Materials
in Design Engineering

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The Chemistry of Materials Failure page 99

Sparking Characteristics of Metals page 104

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MACHINING COST COMPARISON

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(Relative machinability, 80)

CLIP ASSEMBLY
(including leaves)
Machine fill*
Drill
Tap
hrs per 100 pcs. **4.310**

BLOCK
Cut-off
Slot
Grind
hrs per 100 pcs. **2.641**

TOTAL
hrs per 100 pcs. **6.951**

ELECTROLYTIC T.P. COPPER

(Electrical conductivity 101% I.A.C.S.)
(Relative machinability, 20)

CLIP ASSEMBLY
(including leaves)
Hand fill
Drill
Tap
hrs per 100 pcs. **10.838**

BLOCK
Cut-off
Slot
Grind
hrs per 100 pcs. **4.622**

TOTAL
hrs per 100 pcs. **15.460**

*Parts are assembled, pin drilled, and pinned on a semiautomatic machine. Machine does not operate satisfactorily with Electrolytic T.P. Copper.

†Average for annealed metal—slightly lower in hard tempers

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DECEMBER, 1960 | VOL. 52, NO. 7

Materials in Design Engineering

FORMERLY MATERIALS & METHODS

APPLICATION OF METALS, NONMETALLICS, FORMS, FINISHES

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IT'S LIGHTER THAN YOU THINK!

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New Polyester Film for Electrical and Packaging Uses
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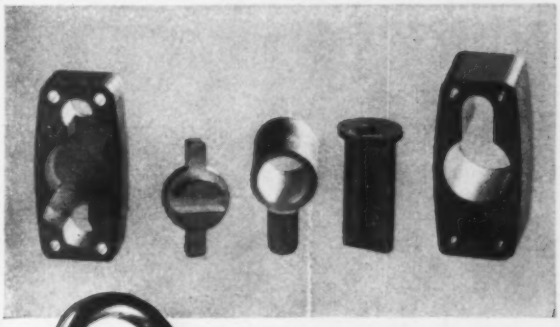
BRASS POWDER METALLURGY...



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Made to military specifications by Reese Padlock Company, this new dead-bolt padlock is built almost entirely of brass powder parts.*

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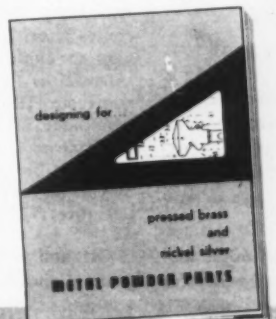
*by REMET, Lancaster, Penna.



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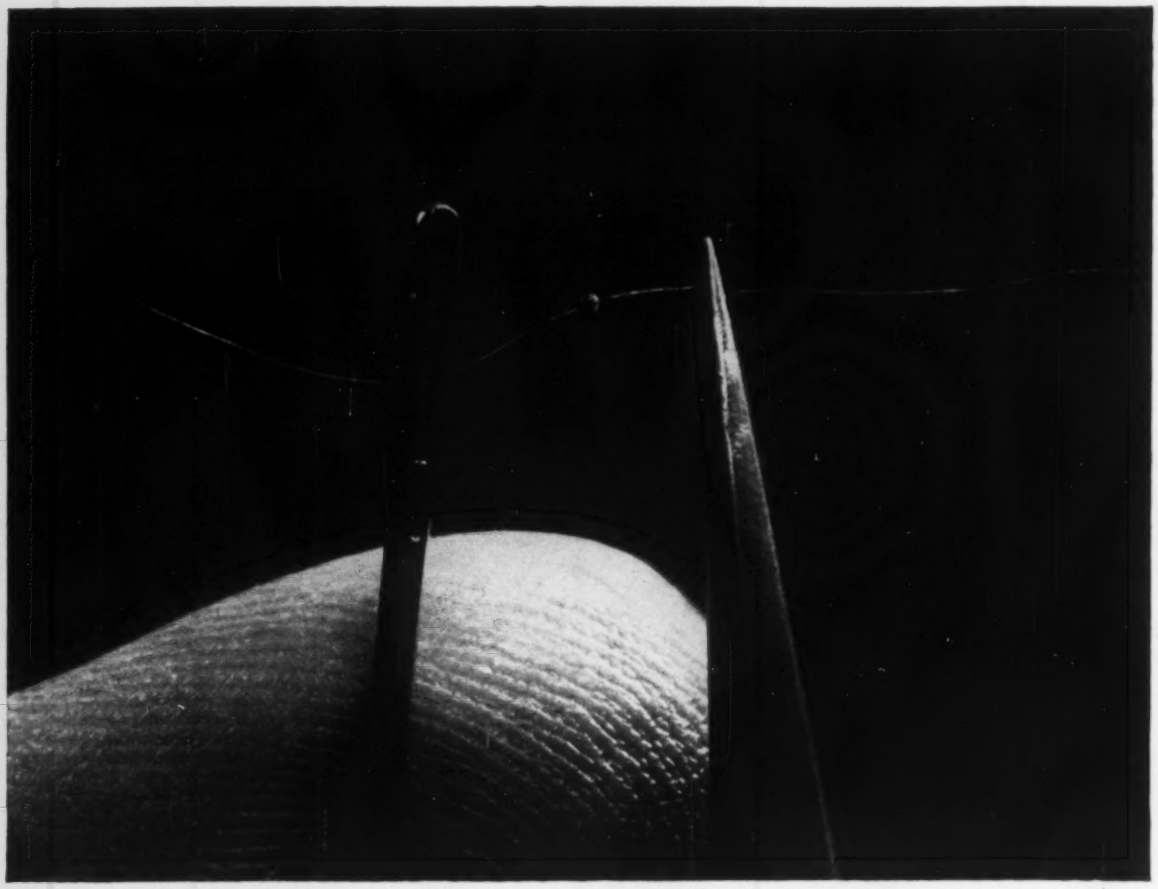

Needle's eye reveals relative size of the thermistor, a tiny bead of Nickel oxide and other materials, used to measure temperatures in and beyond the earth's thin envelope of atmosphere. Made by Gulton Industries, Inc., the thermistor now serves in more than a dozen different missiles and satellites.

"Space thermometer" goes thru needle's eye

Meet the bead thermistor, member of a family of electronic devices now going into everything from midget radios to giant computers and missiles.

This particular thermistor measures temperatures in space — temperatures ranging from 572°F all the way down to 76° below zero Fahrenheit.

You can hardly see the bead with your naked eye. Although it's only *a hundredth of an inch* in diameter, and the lead wires are a mere thousandth of an inch thick, the thermistor is an extremely stable and rugged device, accurate to within a fraction of a degree Fahrenheit.

Made of Nickel oxide and other materials, the thermistor is a space-traveler in many of today's missiles and satellites. It reliably reports on gradients of temperature within the earth's thin atmospheric shield and in outer space. At the same time, it helps record the temperature changes in the missile's skin and its interior.

What is a thermistor? Its name, which comes from THERMal resISTOR, begins to explain. Temperature changes as small as 1/50th of a degree produce a measurable change in the electrical resistance of the pellet. The resulting increase or decrease in circuit current can then be used directly, as a signal, or can be recorded in the form of temperature readings.

Originally developed by Bell Telephone Laboratories for communications equipment, thermistors are now widely used where a tiny, precise, and dependable thermometer is needed: in medical research, in over-load switches to protect electric motors, and in shipment of perishable foodstuffs, for example.

The role of Nickel in the thermistor is only one example of the remarkable versatility of this element.

Be sure to investigate Nickel and Nickel compounds whenever you are faced with a problem calling for unusual electrical or electronic properties... in fact, for *any* unusual metal problem. And don't hesitate to call on us for technical data to help you solve your material-selection problems.

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What's new IN MATERIALS

...AT A GLANCE

Titanium diboride shapes of unprecedented size, strength and purity are being turned out by a new process, details of which have not been revealed. Cylinders 14 in. in dia, 10 in. long and weighing 260 lb have been produced. Titanium diboride is said to maintain a flexural strength of 35,000 psi over the temperature range 77 to 3600 F, making it the strongest material known at these elevated temperatures. (More details in a forthcoming issue.)

Source: National Carbon Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17.

Water soluble baking finishes containing a new thermosetting resin are said to have excellent resistance to water at 100 F, good impact resistance, and excellent freeze-thaw stability. The water soluble resin has good adhesion and is easy to formulate.

Source: Cargill, Inc., 200 Grain Exchange, Minneapolis, Minn.

Steel tubing in a wide range of sizes is being turned out by a new centrifugal casting method in which ceramic-lined metal flasks are used for casting. The producer says outside diameters of tubes can range from 2.25 to 50 in., and wall thicknesses from 0.25 to 8 in. The cast steel tubes are said to be free of imperfections such as hot tears and cracks.

Source: American Cast Iron Pipe Co., P. O. Box 2603, Birmingham 2, Ala.

Metal surfaces that are normally resistant to fluxing can now be soldered effectively by using a new liquid rosin flux. The flux is especially useful for dip soldering printed circuits. It can be used with brass, bronze, cadmium plate, copper, silver and tinplate.

Source: Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J.

An improved vinyl chloride resin has been tailored for heavy-gage sheeting such as swimming pool liners. The developer says the resin absorbs large amounts of plasticizers, forming a dry, free-flowing mixture. The resin can be preblended at room temperature. It has good calendering properties and is free from gel particles.

Source: Goodyear Tire & Rubber Co., Chemical Div., Akron 16, Ohio.

A new self-extinguishing grade of styrene sheet is expected to compete with vinyl and acrylic sheeting for lighting applications. Reason: color stability and light transmission characteristics of the medium impact sheet are said to be far superior to those of vinyl sheet. And in break resistance the material is comparable to vinyl and better than acrylic. Tests show the new styrene sheet is color stable up to 50,000 lighting hours under fluorescent lamps; in contrast, vinyl sheet discolors quite rapidly.

Source: Sheffield Plastics, Inc., Sheffield, Mass.

A multi-layer coating of chromium, silicon and rhodium has been used effectively to protect tungsten wires against oxidation at temperatures up to 3000 F. The coating is still under development and is effective only for periods up to 20 min. But

tests show that improved protection is possible if there is complete diffusion alloying and bonding of the coating.

Source: Rpt. No. PB 161736, Office of Technical Services, Dept. of Commerce, Washington 25, D. C.

Less costly rigid urethane foams of the polyester type can be obtained by substituting wood flour for some of the polyester resin in the foaming system. Wood flour costs only 2¢ per lb. Preliminary work shows that wood flour reacts with isocyanates in the foaming system and actually becomes an integral part of the polymer chain. Foamed-in-place wood flour-urethane combinations are promising for thermal and acoustical insulations, and for packaging materials.

Source: Wilner Wood Products Co., Norway, Me.

Two improved metals for automotive applications have been introduced recently. One metal is a bright annealed stainless steel strip said to have a mirror-like finish and better corrosion resistance than strip now used. It is available in tonnage quantities in the types and sizes most used by auto manufacturers. The other metal is a new brass designed for automobile radiator tanks. It is said to have 53% greater yield strength, 15% greater tensile strength and 35% greater fatigue strength than conventional radiator brasses.

Sources: Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22 (stainless steel); Chase Brass & Copper Co., Waterbury, Conn. (brass).

The trend toward use of aluminum in piston engines (M/DE, Nov '60, p 147) may be accelerated by the development of modified aluminum–21% silicon alloys with ultimate tensile strengths approaching 50,000 psi. Alloys of similar composition have been used in Europe for some time, but have poor foundry characteristics, excessive variations in properties and poor machinability. The modified alloys are said to overcome all these drawbacks with the added advantage that they have the finest possible microstructure.

Source: Ford Motor Co., Engineering and Research Dept., Dearborn, Mich.

Better looking and longer lasting electroplates are said to result from a new semibright nickel plating process. A big advantage is that the plating bath is free from breakdown products. The method involves the use of two addition agents, which, when combined, promote plate uniformity and consistency on uneven surfaces of formed metal parts.

Source: Udylite Corp., 1651 Grand Blvd., Detroit 11.

Synthetic rubber foam, although still under development, may eventually compete with natural and other types of foams for a variety of industrial and consumer applications. The new material is made by what is described as a "cheap and fast" method: polyvinyl methylether causes tiny, solid rubber particles in synthetic rubber latex to cluster or agglomerate into larger particles.

Source: E. L. Borg, Naugatuck Chemical Div., U. S. Rubber Co., 1230 Ave. of the Americas, New York 20.

A new methyl methacrylate monomer has been designed specifically for use in indoor and outdoor signs, and in lighting fixtures. Sheeting cast from the monomer is impervious to all kinds of weather and will not yellow.

Source: E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Wilmington 98, Del.

Turn to page 9 for more "What's New in Materials"

Another new development using

B.F.Goodrich Chemical *raw materials*

ULOK Brand Cube-Type Filters, developed by Union Carbide Development Company, a Division of Union Carbide Corporation, New York, N. Y., offer the face area of a 30" x 30" air filter in the frontal area of a standard size filter, 20" x 20". Non-woven material is Dynel modacrylic fiber bound with Geon vinyl latex by Fiber Bond Corporation, Chicago, Illinois. B. F. Goodrich Chemical Company supplies the Geon vinyl latex.

New, cube-shaped air filters use non-woven made with Geon

The unusual shape of this new replacement air filter is planned to take advantage of a fibrous filter medium of uniform density—a non-woven construction made with Geon vinyl latex as a binder. The cube shape presents more filtering surface to the air stream, providing far higher efficiency over far longer life.

The filter design demonstrates how the unusual balanced physical properties of Geon latex as a binder can pay off. Geon is responsible for the resilience and strength in the batt, allowing the material to be cut, sewed, and formed into the required shape while still maintaining its 2" loft.

Here's another example of the way that versatile Geon vinyl can help to improve a product or open new markets. For more information about Geon and the many different ways you can use it, write Dept. GV-6, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Geon VINYLS

B.F.Goodrich Chemical Company
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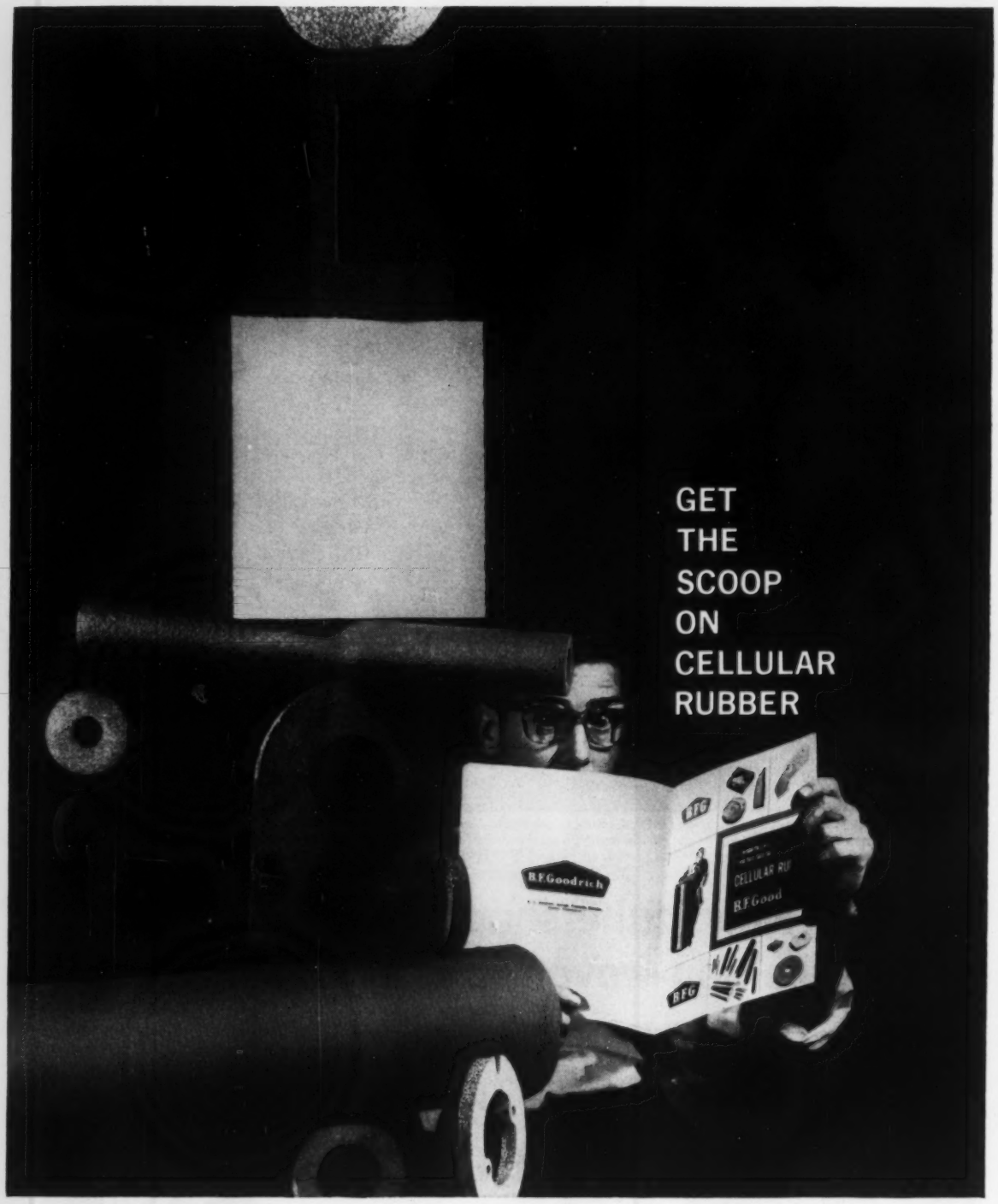

This 28-page B.F.Goodrich booklet is filled with information on properties, test data on BFG cellular rubber. Tells how to use this versatile material for insulation, sealing, cushioning, flotation, shock absorption, vibration dampening. Send request on your company letterhead. The B.F.Goodrich Company, 121 Derby Place, Shelton, Connecticut.

INDUSTRIAL CELLULAR MATERIALS BY B.F.Goodrich

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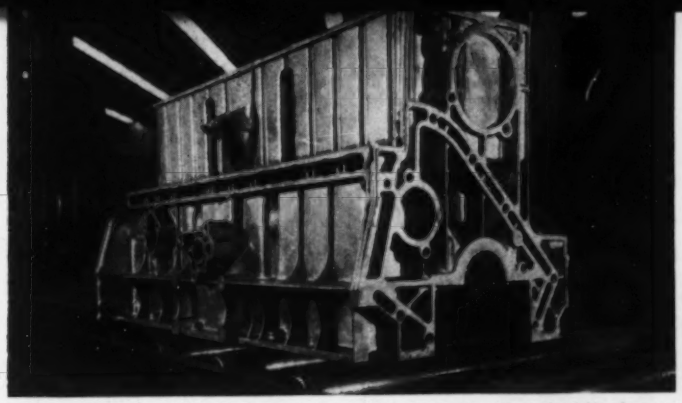
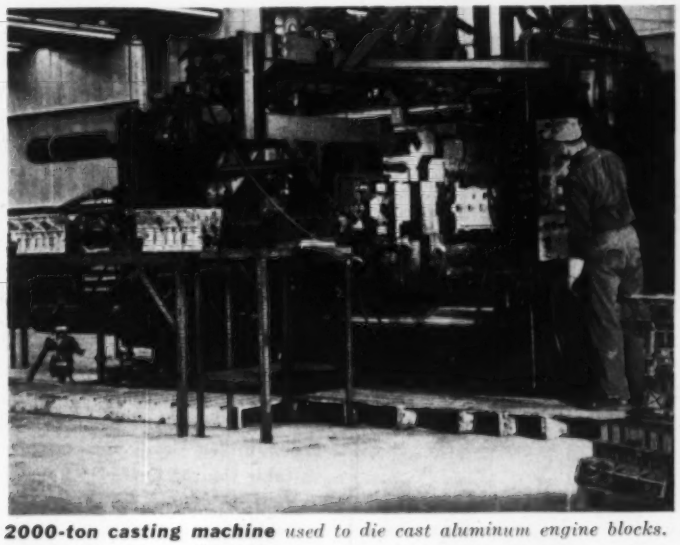
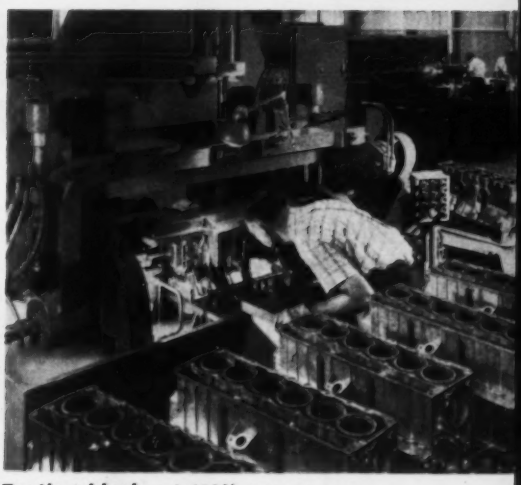


Die cast engine block. *It contains 53 lb of aluminum and 14 lb of cast-in iron liners.*



2000-ton casting machine *used to die cast aluminum engine blocks.*



Testing blocks *at 100% pressure.*

Aluminum Engine Block Die Cast for Rambler

■ Aluminum engine blocks are being successfully die cast for American Motors Corp.'s Rambler. They are the first die cast blocks used in an American automobile engine.

The six-cylinder, in-line block weighs 67 lb—53 lb of aluminum and 14 lb of cast iron cylinder liners. This is 80 lb lighter than the previous cast iron blocks, according to Doehler-Jarvis Div. of National Lead Co., producers of the castings.

Other developments in aluminum engines were discussed in "Automobiles: What Materials Are Next?" which appeared in M/DE last month.

Block is one-shot casting

The engine blocks are produced on special 2,000-ton die casting machines. Liners and camshaft bores are incorporated in the single operation.

The 65 lb of molten aluminum-silicon alloy required for one "shot" in making the engine block is poured into the machine's hot sleeve from an automatic ladle and is injected into the die in 0.3 sec under 8,000 psi pressure. The dies are locked against this high injection pressure by large hydraulic cylinders and mechanical locks for the large side cores of the die. An example of the high pressures developed by the injected metal: pressure against one of the large side cores is 3.3 million pounds.

Iron liners centrifugally cast

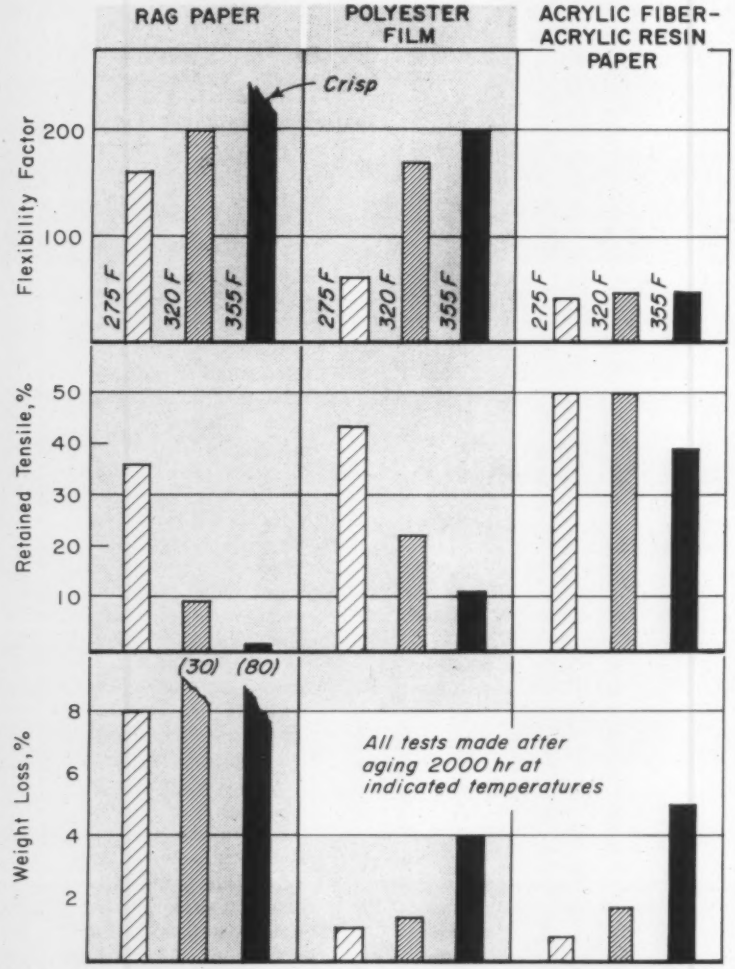
Dry, cast-in cylinder liners have replaced wet, set-in sleeves in the new block. The cast iron liners are centrifugally cast and are chemically and mechanically bonded to the aluminum in the block casting operation. Their extra hardness plus lower cylinder wall temperatures give them better durability and longer operating life than those of corresponding gray iron engines.

In addition, the camshaft bores have been cast with loose pieces. This has been considered undesirable in the past because hand placing the pieces slows production. This handicap was overcome by equipping the die casting machine with an automatic loading and unloading device which puts loose pieces and the six liner inserts into the die automatically.

New Synthetic Fiber Papers for Electrical Uses

offer economy and good resistance to heat and chemicals.
An all-acrylic paper is available now . . . better types are on the way.

by R. C. Berry, G. R. Traut and N. L. Greenman, *Rogers Corp.*



1—Effects of heat aging the new acrylic fiber paper-acrylic resin binder material, compared with aging of rag fiber paper and polyester film.

■ Synthetic fiber papers have mechanical properties similar to those of rag fiber insulation papers, but can provide substantially superior chemical resistance, thermal stability and dielectric strength. One type, an all-acrylic system now available in pilot plant production, is suitable for 130 C (265 F) uses; other types under development appear suitable for 155 C (311 F) service.

Benefits that synthetic fiber papers offer over insulating fabrics include:

1. *Economy*—The papermaking process is inherently a high pro-

Adapted from a paper presented at the National Insulation Conference, Dec '60, Chicago.

TABLE 1—COMPARATIVE PROPERTIES OF ALL-ACRYLIC PAPER INSULATION

Type ➡	Rag Paper	Polyester Film	Acrylic Paper with Acrylic Binder
Thickness, in.	0.015	0.010	0.015
Specific Gravity	1.37	1.40	1.15
Ten Str (D828), 1000 psi			
Longitudinal	15	21	10
Transverse	8	21	5
Edge Tear Str (Finch; T470*), lb			
Longitudinal	55	350	26
Transverse	75	300	41
Internal Tear Str (Elmendorf; D689), gm			
Longitudinal	650	240	675
Transverse	1000	365	1200
Dielec Str (D149), v/mil	600	2800	750

*TAPPI test method. Others are ASTM.

TABLE 2—PROPERTIES OF EXPERIMENTAL VS COMMERCIAL FLEXIBLE INSULATIONS

	Experimental				Commercial—130 C (265 F)				
Designation ➡	A	B	C	D	E	F	G	H	I
Structure ➡	Impregnated Paper				Mat on Polyester Film	Mat on Polyester Film	Fabric	Fabric	Fabric
Fiber ➡	Polyester				Polyester	Polyester	Glass	Glass	Glass
Resin Binder ➡	Epoxy	Polyester	Acrylic A	Acrylic B	Epoxy	Epoxy	Polyester	Polyester	Acrylic B
INITIAL PROPERTIES									
Thickness, in.	0.012	0.011	0.008	0.008	0.010	0.010	0.010	0.010	0.013
Ten Str (D828), 1000 psi									
Longitudinal	7.2	9.0	11.6	13.7	10.2	16.6	5.2	4.7	30.0
Transverse	5.6	6.7	8.0	10.7	—	—	—	—	30.0
Edge Tear Str (Finch; T470[a]), lb									
Longitudinal	43	78	101	98	—	—	—	—	31
Transverse	79	92	107	120	155	176	58	40	31
Dielec Str (D149), 1000 v/mil	1.6	0.8	1.1	1.6	2.2	1.4	1.5	1.9	1.0
EFFECTS OF HEAT AGING									
Flexibility Factor (D1170[b]) after 800 Hr at:									
275 F	6.3	29	8.9	9.3	7.5	7.5	40	30	5.8
320 F	50	118	30	56	20	40	70	75	15
350 F	54	137	47	75	32	75	90	100	23
Retention of Ten Str, %, after 2000 Hr at:									
275 F	108	47	91	58	98	66	48	44	92
320 F	49	27	67	33	37	18	4	32	67
350 F	35	9	39	17	8	14	4	23	44
Weight Loss, %, after 2000 Hr at:									
275 F	1.0	3.7	2	1.2	1.5	1.4	17	17	1.2
320 F	5.0	18.3	17.5	14	4.7	4.6	24	24	4.4
350 F	8.5	30	31	15.5	8.4	9.0	36	30	13.2

[a]TAPPI test method. D methods are ASTM. [b]Min. dia. of bend divided by thickness.

duction, low cost process. Consequently, for any given type of fiber, producing a paper is usually less costly than weaving a fabric.

2. *Variety of thicknesses* — Greater freedom in selection of thicknesses of papers permits saving in space and cost where thinner materials can be used.

3. *Processability* — Paper is more easily cuffed and formed than fabrics.

4. *Neatness*—Smooth, fuzz-free, non-abrasive surfaces and cut edges of paper make a neater assembly than fabrics, and have less tendency to damage wire insulation.

One material available

At present Rogers Corp. has one material available in pilot plant quantities. An all-acrylic system, the material is produced by combining acrylic resin with acrylic fiber by a papermaking process. The material is presently used in some large hermetic motors and some small 130 C motors. One of the primary benefits the material offers over polyester film is superior resistance to hydrolytic degradation.

Properties of the material are compared with those of rag paper and polyester film in Table 1. Note that the mechanical properties of the new paper are similar to those of the rag paper. The acrylic paper, like rag paper, has higher resistance to tear propagation than polyester film, as indicated by Elmendorf tear strength. This is important in winding electrical machinery. Initial tear strength of the acrylic system, however, as measured by the Finch method, is inferior to that in both rag paper and polyester film.

Thermal stability of the acrylic system is surprisingly good, as shown in Fig 1. The acrylic system is more stable at each of the three test temperatures, as well as less sensitive to changes in the aging temperature than rag paper or polyester film.

Dielectric strength of all three materials usually improves or remains unchanged after heat aging. Decreases occur only in materials with extremely high weight losses on aging, e.g., rag paper after 2000 hr at 350 F.

Polyester fiber papers are promising

Because polyester fibers have substantially higher strength than acrylics, polyester fiber papers have received the most attention

for 130 C and 155 C systems. Although these materials are still experimental, they appear promising when combined with certain acrylic and epoxy resin bonding systems.

Table 2 compares properties of four polyester paper-base systems, combined with different resin binders, with five commercial 130 C insulation systems.

The experimental paper-base materials have mechanical and electrical properties intermediate between those of the strongest and the weakest commercial structures shown. On the basis of thermal stability, flexibility, retention of tensile strength and weight loss, the epoxy resin-bonded polyester paper (A) offers the best combination of properties. The acrylic-bonded polyester paper (C) is a close second, inferior only in its relatively high weight loss at 320 and 350 F.

Effects of aging on the epoxy-polyester fiber paper (A) are shown in Fig 2-4, compared with three of the better commercial 130 C insulations. Fig 2a shows the superiority of the epoxy-polyester in tensile strength retention and weight loss at 265 F; Fig 2b indicates that at 320 F, the new material loses more tensile strength, but less weight, than the acrylic-resin-impregnated glass fabric (I); Fig 2C shows A and I to be fairly comparable in tensile strength loss, and to be rivalled in low weight loss only by a commercial material (E) consisting of polyester mat saturated with epoxy resin and bonded to polyester film.

From these data, we believe that the epoxy resin-polyester paper material is satisfactory for 130 C use and may be capable of 155 C service.

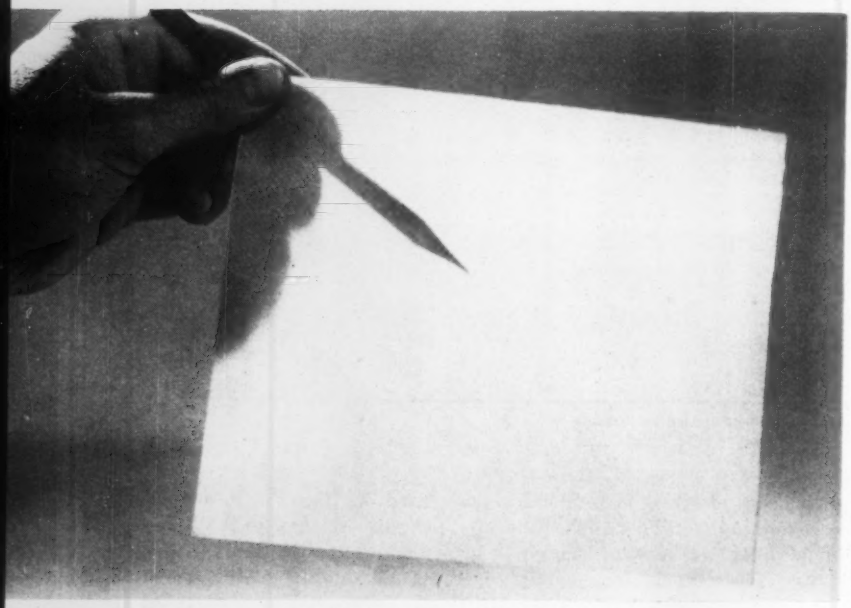
Direction of future work

The search for superior resin systems is continuing. We are also studying modification of the paper by incorporation of small quantities of inorganic fibers to improve heat aging properties.

The purpose of the data given in this article is to compare these developmental materials with known commercial insulations. Data are unavailable as yet on effects of moisture, continuous vibration, and thermal cycling.

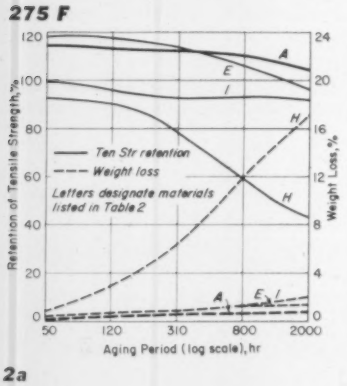
Simulated service tests are now being run on four-pole induction motors hand-wound with 130 C insulated wire. Each of the four running coils is insulated with a different sheet material, including both commercial materials and the newer synthetic fiber papers. The motors will be run at elevated temperatures, with periodic checks of resistance of each coil to ground, until failure.

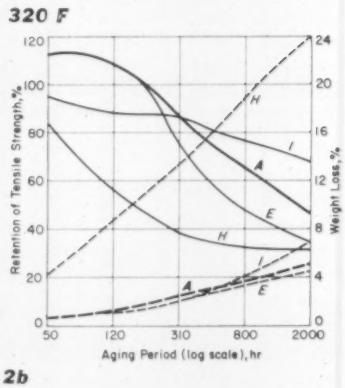
For more information, circle No. 600

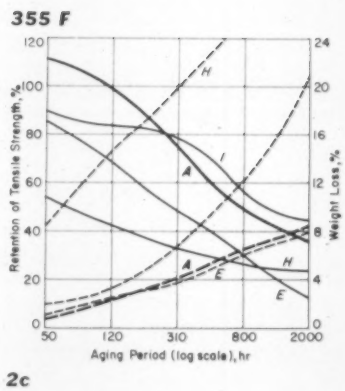


New papers *can provide thermally stable insulations.*

EFFECTS OF AGING AT . . .







***New transistor** is just a tiny speck inside the clear quartz tube being heated by the gas flame. Oscilloscope trace shows that the transistor functions perfectly when heated to temperatures at which conventional germanium or silicon transistors fail.*

Silicon Carbide Transistor Can Be Used at 600-900 F

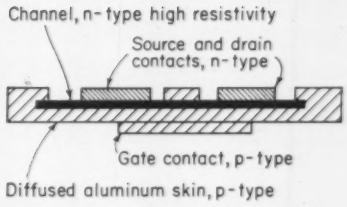
■ A significant advance in the production of silicon carbide has enabled scientists of Westinghouse Electric Corp. to produce the first transistor capable of operating over 650 F. Because of its desirable electrical properties at elevated temperatures and its high chemical stability, silicon carbide is now one of the most promising transistor materials for extremely high temperature applications—notably present and future aircraft and space vehicles.

Use over 925 F foreseen

Present-day transistors manufactured from germanium and silicon can operate at temperatures no higher than about 200 F (germanium) to 400 F (silicon). However, laboratory tests show that the new silicon carbide transistor (which is still in the development stage) is effective up to 670 F. The transistor has a power gain of about 60 at room temperature and this ability to amplify continues as the temperature is raised up to 670 F. With further development, scientists expect that the silicon carbide transistor can be used at higher than 925 F.

Operating principle differs

The new silicon carbide transistor is a unipolar transistor and differs in operating principle from the bipolar germanium and silicon types. A bipolar transistor regulates the flow of current by the injection of electric charge carriers across a junction built into the semiconductor material. The unipolar transistor, on the other hand, acts more like a valve which opens or closes to regulate electron flow across the junction.



***Cross section** of SiC transistor. Electrolytic etching is used to expose n-type region for source and drain contacts. These two contacts are made by alloying n-type silicon to n-type material exposed in etch pits. Gate contact is made by alloying p-type silicon to diffused p-surface.*

How it is made

Development of the unipolar silicon carbide transistor was made possible through two important advances: the recent availability of silicon carbide crystals of exceptional purity, and the perfection of techniques to form the semiconductor junction in the material, i.e., the development of ways to clean, etch, solder and otherwise handle the inert silicon carbide crystals.

The silicon carbide transistor is made from crystals about 2 mils thick. These crystals have an impurity content of less than one part in 10 million. The semiconductor junction is built into the material by exposing it to vaporized aluminum at 3900 F. At this temperature the aluminum atoms diffuse into the silicon carbide, changing its electrical behavior from n-type to p-type. The junction is formed where the two types meet, and the diffusion process is controlled to within a few millionths of an inch.

To construct the input and output terminals of the transistor, the wafer is etched at two points until the junction within the body of the crystal is reached. Electrical connections at these two points and to the body of the wafer complete the transistor. A typical finished transistor is about 80 mils long and 40 mils wide, and the "working" area of the crystal surface is smaller than the head of a pin.

For more information, circle No. 601

First Data on High Modulus Glass

■ The bar charts show the first available data on the performance of the new high modulus glass fiber (see M/DE, Aug '60, p 133) in reinforced plastics laminates. When optimum resin-finish systems are used the new reinforcement provides higher strengths than conventional E glass and increases modulus about 25 to 45%. In filament form, the new fiber has a modulus of about 17 million psi, compared with 11 million psi for conventional E glass. Tensile strength is equivalent to that of E glass.

The new fibers are drawn from a beryllia-containing glass developed by Owens-Corning Fiberglas, Inc. under contract to Materials Central, Wright Air Development Div. (Air Force). Designated YM-31-A, the fibers are now in pilot plant production. According to W.M. Keller of Owens-Corning, modest inventories of singles, and 8, 12, and 20-end rovings with 801 sizing are stocked in its regional warehouses at an introductory price of $65 per lb.

The accompanying data, as well as information on fabrication and handling of the material were presented in October at a symposium on High Modulus Glass Fibers for Structural Plastics, sponsored by the Plastics Branch, Nonmetallic Materials Laboratory, Materials Central, WADD.

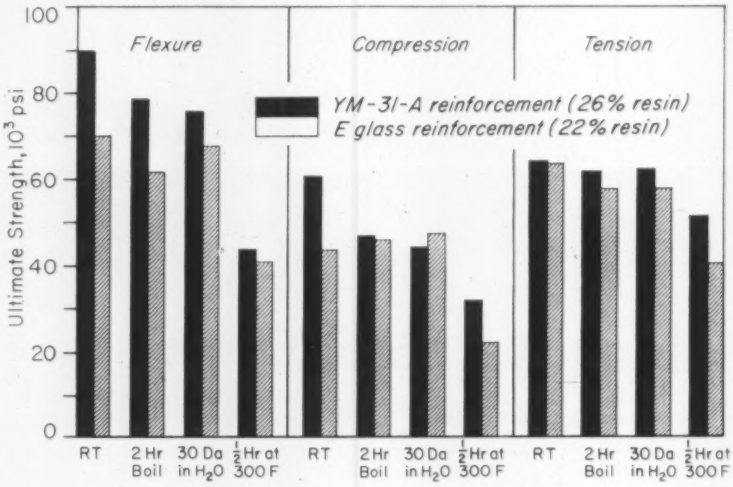
Properties of laminates

Although most initial work on high modulus glass reinforcement was in filament wound reinforced plastics, property data presented by G.P. Peterson of WADD described its use in epoxy laminates reinforced with 181-style cloth.

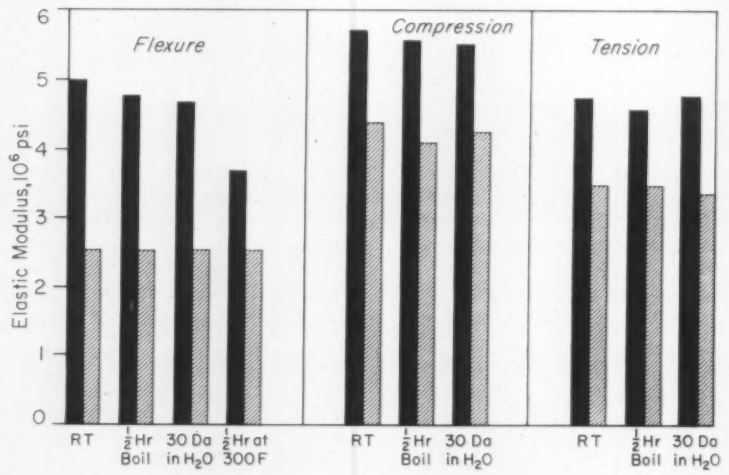
Effect of resin and weave — According to Peterson, the performance of laminates made with the new reinforcement in the form of 181-style cloth is highly dependent on the resin-finish combination used. WADD found that an epoxy resin system (Epon 828 with CL curing agent) in conjunction with an A-1100 finish (acidified to pH 6) provided best performance. In addition to its good adhesion, the resin's ductility is sufficient to permit deform-

Here's how laminates compare in . . .

Strength



Elastic modulus

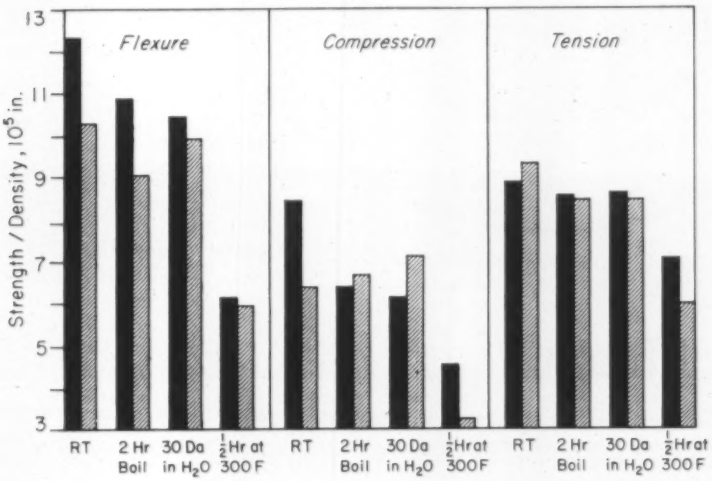


Fibers for Reinforced Plastics

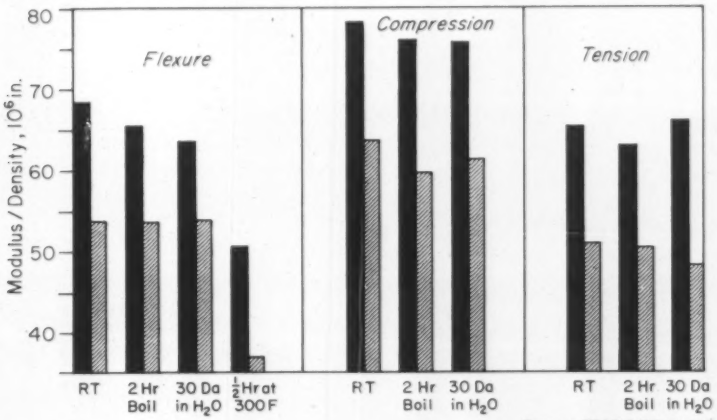
ation of yarns in the reinforcement to absorb applied loads.

The form of reinforcement has a decided effect on strengths obtainable with YM-31-A. Since the new fiber is stiffer than E glass, Peterson concludes that yarn constrainment plays an important part in determining the strength of laminates made with glass. For example, plain weave fabrics such as 128-style impose more constraint on woven yarns, and thus produce lower strengths than an 8-harness satin weave (181-style). Use of a crow foot satin weave (143-style) or parallel strand reinforcement, which results in even less constraint, produces even higher strengths.

Specific strength



Specific modulus



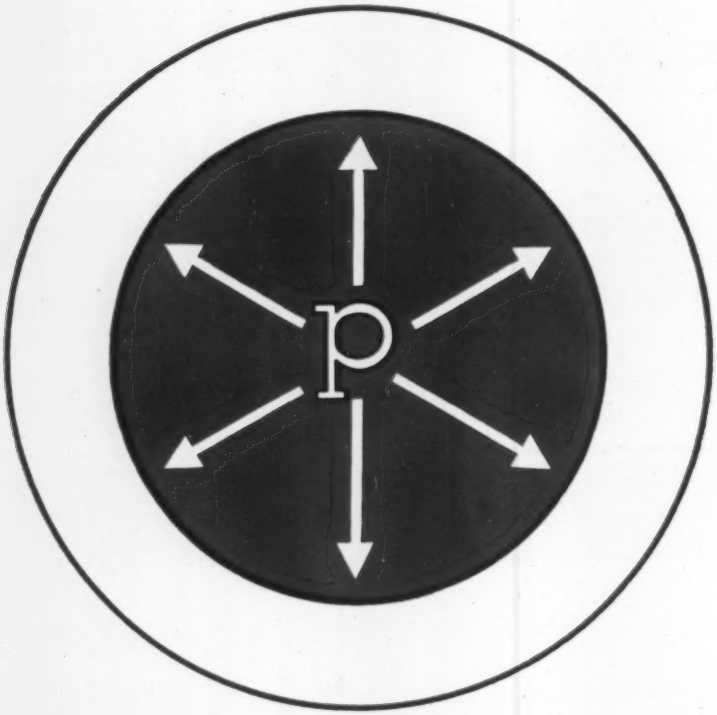
Source: WADD TR 60-735.

Mechanical strength—The comparative data in the bar charts were derived from 181 cloth-epoxy laminates press-cured at 80 psi for 1 hr at 250 F, then post-cured 1 hr at 375 F. Note the excellent strength and modulus values displayed by the YM-31-A laminates for virtually every test condition evaluated, particularly flexural and compressive strengths. The most severe losses occurred in compressive strength after the 2-hr boil and in the strength properties obtained at 300 F after ½ hr at 300 F. But the moduli were affected much less than the strengths.

Strength and modulus per unit weight, or specific strength and modulus, are of critical importance in aircraft or space vehicle design. The YM-31-A fiber has a higher specific gravity than E glass, i.e., 2.89 vs 2.58. In the specimens tested, according to Peterson, average densities of the laminates were 0.0729 lb per cu in. for those using YM-31-A; 0.0686 lb per cu in. for those using E glass.

This increased weight of the high modulus fiber laminates reduces their margin of superiority somewhat on a strength-to-weight basis; however, as the last two bar charts show, the YM-31-A reinforcement still offers a considerable advantage.

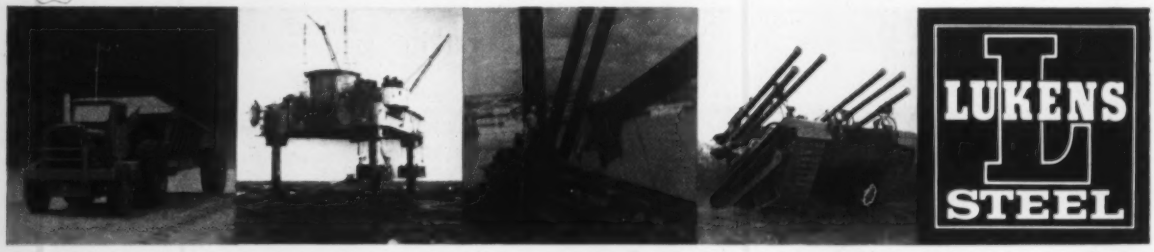
Electrical properties — Electrical tests on both all-glass patties and glass-reinforced epoxy



Metallurgical Phenomena... and the metals to cope with them.

These are the stock-in-trade of the Lukens Application Engineer—whether the problem be one of pressure (symbolized above) or corrosion or abrasive impact or structural stress or high and low temperature. Investigation of the best steels for "problem" applications has been carried on for years by the Lukens Application Research team. We would welcome the opportunity to contribute the results of this research to your own design knowledge. Please contact us in your early design stages. Call collect: John D. Heffernan, Manager of Application Engineering, Extension 422, Lukens Steel Company, Coatesville, Pennsylvania. Or write: D-120 Services Building.

HELPING INDUSTRY CHOOSE STEELS THAT FIT THE JOB



For more information, turn to Reader Service card, circle No. 392

laminates were conducted for WADD by Massachusetts Institute of Technology. According to Peterson, electrical properties of YM-31-A are only slightly inferior to those of E glass at temperatures ranging up to 300 F (dielectric constant for YM-31-A laminates was about 5.5; loss tangent was 0.0154 to 0.0270 over a temperature range of 78 to 300 F). At temperatures of 575 to 950 F, tests of bulk YM-31-A glass indicate that electrical properties change so rapidly that the material would be unsatisfactory for precision radar guidance applications. However, further data must be developed.

Toxicity discussed

Toxicological problems that could arise during fabrication of laminates with this beryllia-containing glass were discussed at some length by L.J. Schafer and Dr. L.H. Miller of Kettering Laboratory. Extensive tests were carried out to determine concentration of beryllium compounds in the air during various operations involving YM-31-A. Operations studied included research investigations, forming the fibers, molding the laminate, and sawing and sanding the cured laminate.

The glass cullets from which the fibers were made averaged about 8% beryllia, or 2.9% beryllium. The beryllium was present in the glass in the form of beryllium silicate.

Schafer and Miller pointed out that "any potentially harmful material can be handled and processed safely and without apprehension provided proper industrial hygiene and medical control practices are maintained." Apparently they concluded that possible hazards in handling this high modulus glass were relatively small. However, they recommended certain specific conditions which should be met in plants and by workers handling the material. Owens-Corning requires customers to sign "release" forms to help ensure that such conditions will be met.

For more information, circle No. 602

Diffusion Coatings Protect Metals to 2300 F

■ Diffusion coatings that increase the oxidation resistance of metal parts at temperatures to 2300 F have been announced by Haynes Stellite Co., Div. of Union Carbide Corp., Kokomo, Ind.

Nickel and cobalt-base alloys, stainless steels and plain carbon steels have been coated with excellent results, it is claimed. Results of oxidation tests on two Haynes alloys are shown in Table 1.

Form protective film

Although Haynes Stellite has not presented any detailed information on the nature of the coatings or the manner in which they are applied, several general observations can be made:

1. Coatings are metallurgically bonded to the base metal and resist spalling, chipping and thermal shock. The coatings can be applied to wrought or cast metals.

2. Thickness of coating ranges from 0.001 to 0.006 in. Dimensional changes in the part are negligible; thickness usually increases by about one-half of the final coating thickness. Internal holes and recesses can be coated.

3. Oxidation resistance of the protected parts increases. Table 1 shows that parts exhibit a weight gain, indicating the formation of an inherent, protective oxide film.

4. As Table 2 shows, parts protected with the diffused coating do not suffer a loss of mechanical properties to any serious extent.

TABLE 1—OXIDATION TESTS SHOW WEIGHT CHANGES
(Mg per Sq Cm)

Haynes Alloy ↓	Dry Air		Oil Ash,[a]
	2000 F, 500 Hr	2300 F, 100 Hr	1800 F, 100 Hr
713C			
Coated[b]	+0.2	−3.1	−71
Uncoated	−3.3	−49.2	−147
152			
Coated[b]	+1.9	+ 1.1[c]	−16
Uncoated	−474.0	Destroyed	−353

[a]With vanadium pentoxide (V_2O_5) and sodium sulfate (Na_2SO_4).
[b]Oxidation was uniform on coated parts.
[c]20 hr.

Two limitations

Present equipment limitations require that parts be no longer than 15 in. by 16 in. by 18 in. Theoretically there is no limitation on the size of part that can be protected.

Since the diffusion process is carried out at high temperatures (unspecified) consideration must be given to adverse metallurgical changes that can occur during processing.

For more information, circle No. 604

TABLE 2—TENSILE PROPERTIES COMPARED FOR COATED AND UNCOATED METAL[a]

Temp, F	Coated	Uncoated
80	123 (8.8)	121 (5.9)
1200	134 (7.3)	123 (8.0)
1600	108 (10.6)	106 (9.7)
1700	87.3 (20.8)	90 (8.5)
1800	64.3 (28.6)	72 (14.0)

[a]Metal is Haynes Alloy 713C. Tensile strengths given in 1000 psi; elongations in parenthesis given as % in 1 in.

Nickel-Free High Temperature Alloy

resists sulfur and sulfur-bearing atmospheres

by D. J. Schmatz
Scientific Laboratory
Ford Motor Co.

■ A new group of austenitic iron-base alloys developed by the Scientific Laboratory, Ford Motor Co., contain no chromium or nickel, yet have excellent oxidation resistance and strength from room temperature up to 1400 F. A typical analysis: 9% aluminum, 30% manganese, 1% silicon and 1% carbon.

Mechanical properties—Tests at room temperature and 1200 F show that the mechanical properties of the typical analysis mentioned are considerably higher than those of type 304 stainless steel. As Table 1 indicates, the new alloys have 70,000 psi yield strength at room temperature, compared to 35,000 psi for type 304 stainless steel. At 1200 F the difference is still more marked: 68,000 vs 12,000 psi.

Ductility is adequate for forming operations although the higher yield strength requires higher working forces during forming. The higher yield, plus the increased work hardening that occurs, necessitates intermediate anneals during forming. These disadvantages are somewhat offset by the increased strength obtainable by cold working.

A combination of cold working and aging can be used to obtain optimum strength in these alloys, as shown in Table 2. Note that cold rolling plus aging at 1100 F results in a 290,000 psi yield. When ductility is too low to meet service requirements, the alloy can be overaged (at 1350 F, for example) to increase ductility at the expense of yield and ultimate strength.

Oxidation and corrosion resistance—Oxidation resistance of the new alloys is adequate to 1400 F. Oxidizing specimens at 1400 F for 100 hr resulted in a weight increase of 0.30 mg per sq cm. An additional 100 hr increased the weight gain to 0.35 mg per sq cm, indicating that the oxidation rate decreases rapidly after an initial film develops.

Although commercial stainless steels are somewhat superior in elevated temperature oxidation resistance, the new alloys are superior in resistance to sulfur and sulfur-bearing atmospheres at elevated temperatures. Tests on welded tubing conducted at Aerojet-General Nucleonics Co. indicated that the alloys were two to three times more resistant than 18-8 stainless steels to sulfur-bearing atmospheres.

TABLE 1—STRENGTH COMPARISON

Alloy ↓	Ten Str, 1000 psi		Yld Str, 1000 psi		Elong, %	
	RT	1200 F	RT	1200 F	RT	1200 F
9 Al-30 Mn, etc.	120	80	70	68	70	18
304 Stainless	85	41	35	12	65	40

TABLE 2—THERMAL-MECHANICAL TREATMENTS FOR NEW ALLOY

Treatment ↓	Ten Str, 1000 psi	Yld Str, 1000 psi	Elong, %
Anneal	120	70	70
Age 1100 F	165	150	25
Anneal, CR 60%	275	270	7
CR, Age 1100 F	300	290	1
CR, Age 1350 F	165	120	29

Glass-Base Laminate

A new silicone-glass laminate has been designed for Class H (360 F) electrical equipment. It is said to have good heat resistance, excellent electrical properties, high impact strength and low moisture absorption. The laminate has an arc resistance of 180 sec, and withstands temperatures up to 390 F.

The material is known as Lamicoid Grade No. 4053-3, and is available from Mica Insulator Div., Minnesota Mining & Mfg. Co., Schenectady 1, N. Y. It is made with a continuous filament, coarse weave glass cloth.

The laminate is supplied in thicknesses from 1/32 to 3/8 in. in 36 × 42-in. sheet sizes, and in thicknesses from 3/8 to 2 in. in 18 × 36-in. sheet sizes. It sells for $4.00 per lb in thicknesses of 0.050 in. and over.

For more information, circle No. 605

MORE WHAT'S NEW IN MATERIALS

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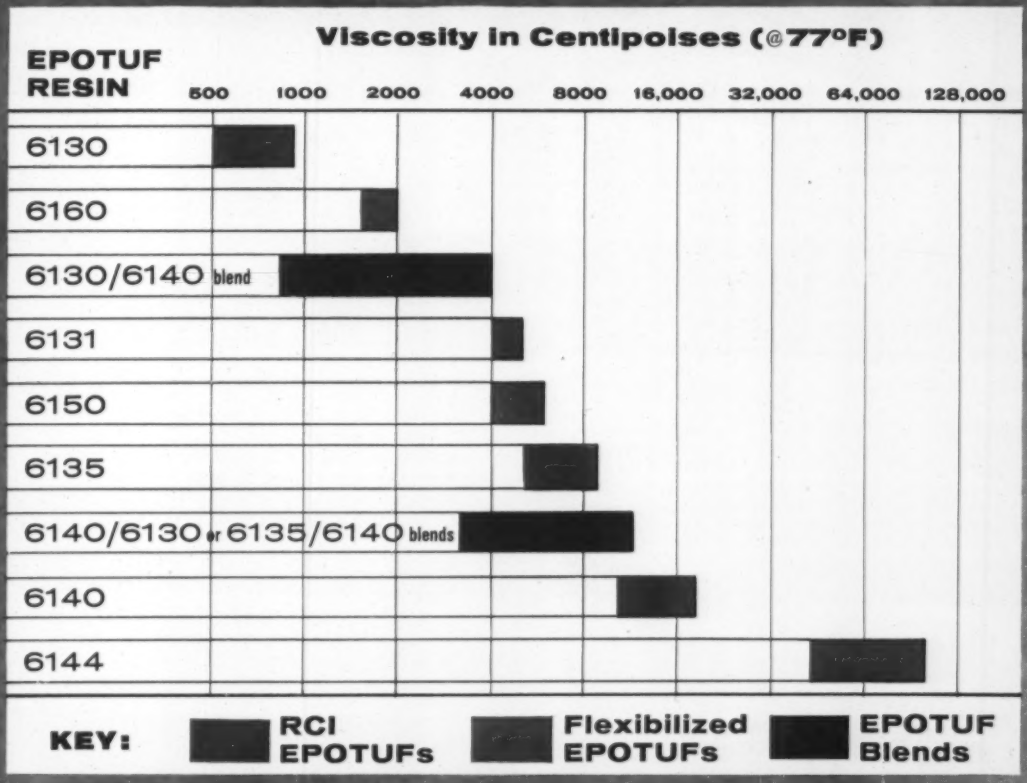
RCI Epotuf Epoxy Resins Meet Every Viscosity Need

CHOOSE THE RIGHT EPOTUF RESIN FOR YOUR NEEDS FROM THIS VISCOSITY SELECTOR CHART:



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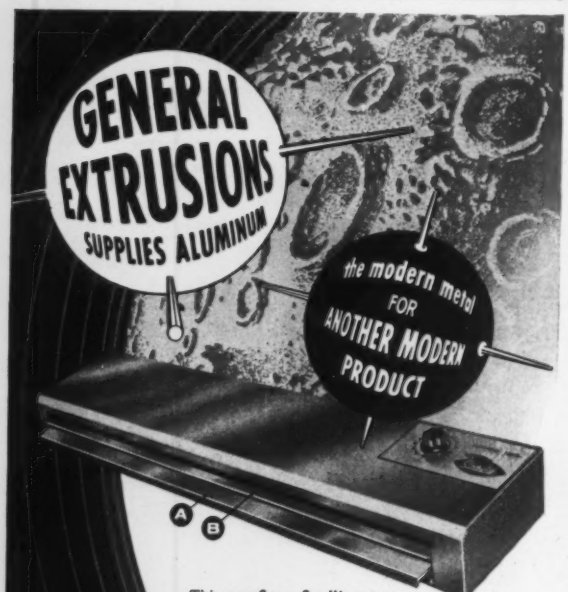

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Materials Age issue

To the Editor:
. . . The content of this report ("The Challenge of the Materials Age," M/DE, Sept '60, pp 123-174) was quite interesting to me because I have a class in Engineering Materials this quarter (approximately 100 students) and I plan to use some of this report to supplement the regular text. What would it cost to obtain 100 or more copies . . . ?

L. E. STEINER
Assistant Professor
Milwaukee School of Engineering
Milwaukee, Wis.

To the Editor:
. . . It appears to be a very thorough and helpful study on this subject . . .

F. S. CORNELL
Executive Vice President
A. O. Smith Corp.
Milwaukee, Wis.

To the Editor:
. . . I have read it from cover to cover and found it most interesting and informative . . .

J. C. MERTZ
Materials Engineer
Pratt & Whitney Aircraft
Div. of United Aircraft Corp.
East Hartford, Conn.

To the Editor:
. . . I have found these articles to be interesting and well written and, when combined, they constitute a comprehensive and informative review of the subject of materials . . .

BIRNY MASON, JR.
President
Union Carbide Corp.
New York, N. Y.

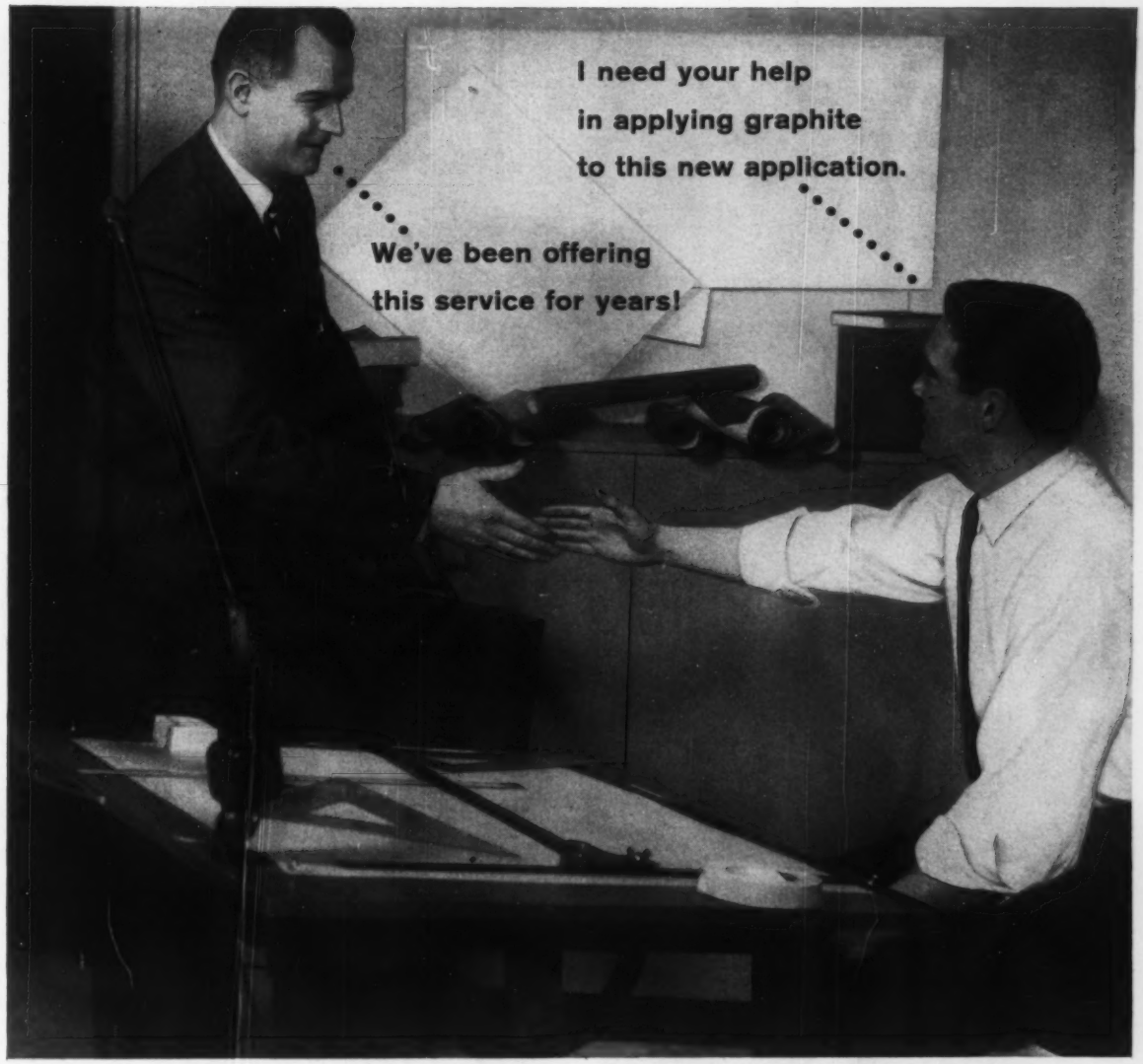
To the Editor:
. . . I must take time to congratulate you on a superb job . . .

ROBERT N. THURSTON
Public Relations Manager
Fabric Research Laboratories
Dedham, Mass.

To the Editor:
. . . I found it very interesting and do feel the importance of the materials engineer certainly cannot be overemphasized . . .

HAROLD N. BOGART
Manufacturing Research Office
Ford Motor Co.
Detroit, Mich.

To the Editor:
. . . It is certainly comprehensive in its scope and covers the field of materials thoroughly . . .
(continued on p 22)



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It is a definite contribution to the vast and growing field of materials literature . . .

BOB CRAFT
Executive Secretary
Society of Aerospace Materials
and Process Engineers
Fort Worth, Tex.

One dissent

To the Editor:

I have read with interest your excellent article. Reference to ceramic engineering education effort, however, is notable by its absence. This is one of the oldest branches of the specialized curriculum in materials. The American Ceramic Society is the parent technical organization and publishes a bulletin, journal and abstracts. The educational group of this society is active both in the education council of the American Ceramic Society and in the American Society for Engineering Education.

A. W. ALLEN
Professor of Ceramic Engineering
University of Illinois
Urbana, Ill.

It was the intent of this special section to call attention to the trend toward a unified *materials field and not to concern ourselves with the progress of individual fields of materials. In our articles on education, we were concerned with the teaching and development of courses covering* all *materials, and not with the development of metallurgical or ceramic engineering courses. In the education field, the unified materials approach does seem to envelop ceramic engineering departments.*

A good place for old M/DE's

To the Editor:

As I lay here in the hospital recovering from a broken leg, the thought occurred to me that a lot of back issues of M/DE usually wind up in the trash. This is a sad waste of valuable material.

I suggest that back issues of the magazine be saved for a year at a time then given to a local library or college. A sample issue of the magazine could be given to the library a few weeks in advance so that the library could accept the back issues through proper channels.

With this arrangement, a person knows where a particular back issue is and can find it a lot quicker than by searching for it in the attic. In addition, back issues of the magazine would be available to any one who wants to use them.

F. D. THOMPSON
Southern Baptist Hospital
New Orleans, La.

Another possible use for back issues of M/DE and other technical magazines was discussed in the Aug '60 issue of this magazine (p 216).

An example of Avisco Rayons in Industry

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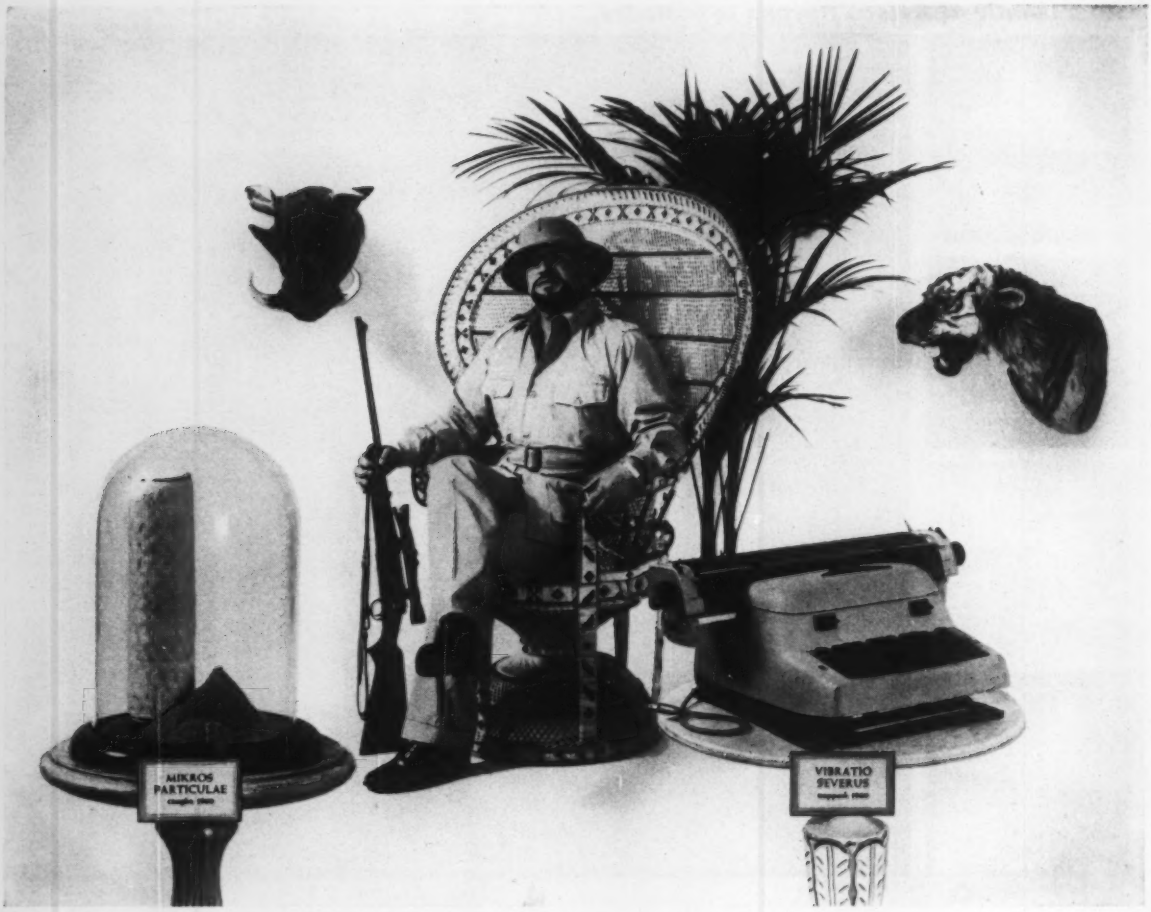

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PRICES & SUPPLY

...AT A GLANCE

A new fluorocarbon plastic—polyvinylidene fluoride—is now in semicommercial production, according to Pennsalt Chemicals Corp. The material, described in the May '60 issue of this magazine (p 9), is presently being offered in the form of molding powder and pelletized resin. Later on it will also be offered as organosols and in the form of solutions in high boiling organic solvents. Called Kynar, it was previously designated RC-2525. Introductory price for the material is $6 per lb.

Price of brass mill products has been increased by Cerro de Pasco Corp. The company's Titan Metal Mfg. Co. Div. increased the base price of its free-cutting brass rod by ½¢ per lb to 34.88¢. And the price of copper and copper alloy tube products produced by Cerro's Lewin-Mathes Co. Div. has been increased 1¢ per lb.

A new supplier of polypropylene will be Shell Chemical Co. The company says it will build a polypropylene plant near Woodbury, N. J. having an initial capacity of 80 million pounds per year. The polypropylene will be made by a new process, details of which have not been revealed. (To find out what users think of polypropylene, see the special report starting on p 117 of this issue.)

World steel production is 13% ahead of last year for the first nine months of 1960, according to the Dept. of Commerce. Japan showed the highest rate of increase with a 35% rise.

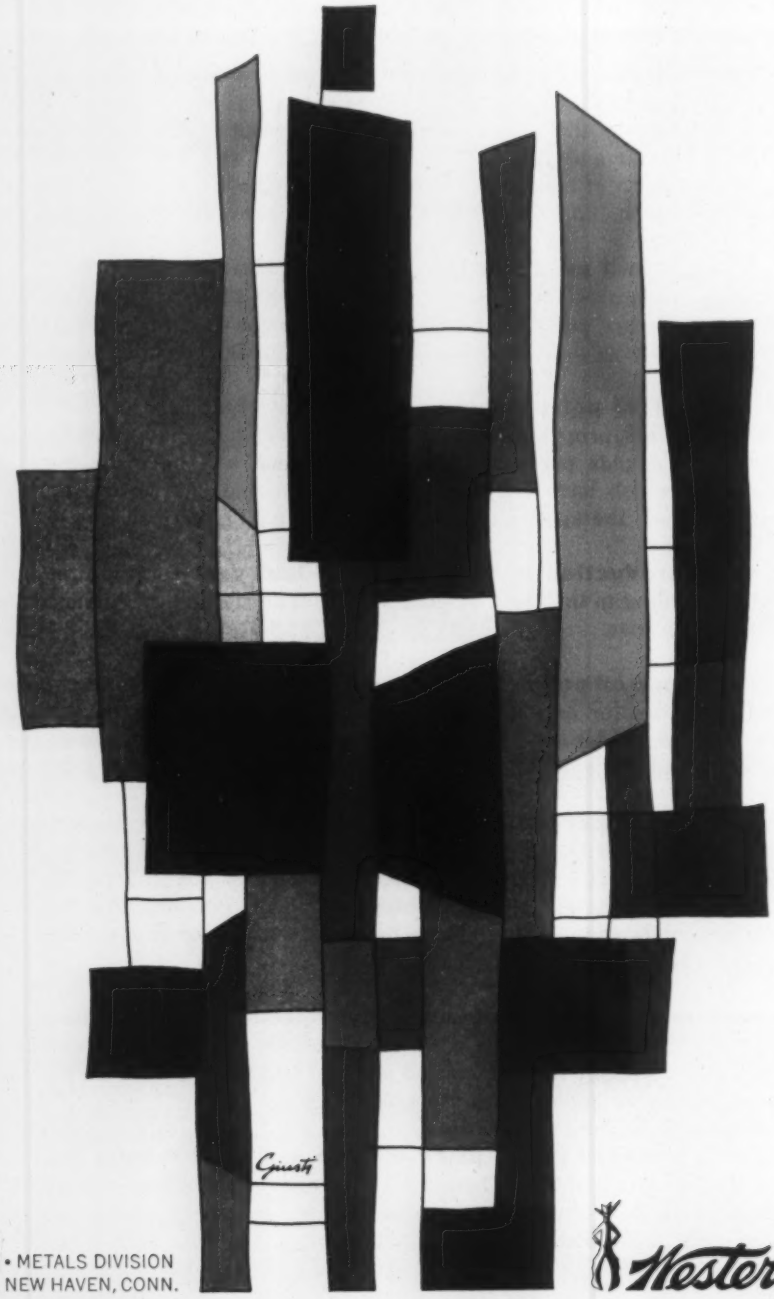
Price reductions on polycarbonate resins have been announced by General Electric Co. New price for natural grade resins is $1.30 per lb in truckload lots, down 20¢ per lb. Color grades now sell for $1.50 per lb in truckload lots, down 25¢ per lb. This is the second price cut for polycarbonates in recent months (M/DE, Aug '60, p 25).

Price cuts on copper-clad steel have been announced by Superior Steel Div. of Copperweld Steel Co. New price of cold rolled steel strip clad on both sides with copper or brass is $43.40 per 100 lb, down 80¢ per 100 lb from the previous price. Steel strip clad on one side with copper is $36.35 per 100 lb, down 45¢ per 100 lb. The price cuts were made possible by the recent 3¢-per-lb reduction in the price of copper (M/DE, Nov '60, p 25).

More 'man-made' natural rubber (polyisoprene) is available as a result of the start-up of Shell Chemical Co.'s new 40-million-pound-per-year plant in Torrance, Calif. The company also announced plans to build a polyisoprene plant of 80-million-pounds-per-year capacity near Marietta, Ohio.

A 2¢-per-lb increase in the price of high purity aluminum has been announced by Kaiser Aluminum & Chemical Corp. and Consolidated Aluminum Corp. New price is 47.50¢ per lb. Not long ago Kaiser increased production of high purity aluminum at its Mead, Wash. reduction plant (M/DE, Aug '60, p 25).

You'll get modern styling, ageless appeal, with Western Brass . . . for the enduring glow of solid brass adds a classic note to contemporary design . . . keeps any design forever young and beautiful. That glow is kindled at Western Brass by meticulous finishing and packing methods, unexcelled in the industry. Moreover, this precision finishing, customers say, actually gives more parts per pound of sheet or strip. You'll make it better with beauty-rich brass. You'll make it best with "tailor-made" Western Brass.



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Gray Iron Founders Told Their Research Inadequate

An unusual example of an industry group under fire was displayed at the 32nd Annual Meeting of the Gray Iron Founders' Society.

The attack came in the four principal invited talks presented to the group. Each speaker told the foundrymen, in effect, to look around and start recovering lost markets before the industry is "shaken out" to the irreducible minimum number of producers needed to supply the nation's gray iron needs.

Losses make research imperative

H. W. Lownie of Battelle Memorial Institute pointed out that the gray iron founders must begin to support an extensive research effort, not only to keep abreast of technological changes in competing industries but also to develop new markets for their product. In the decade between 1947 and 1957, while population increased 20%, demand for cast aluminum and steel ingots increased by 58 and 30% respectively. In the same period, demand for miscellaneous gray iron products *decreased* by 19%.

The low research expenditures of the primary metal producers probably contributes to the decline in sales. The average research budget for all U. S. industry in 1960 is estimated at 2.1% of sales. The figure for primary metal producers is 0.6%, and for the gray iron industry is 0.03%.

Most developments from abroad

The result of the lack of interest in research apparently is that most major foundry developments —such as sheil molds and cores, water cooled cupolas, hot blast cupolas, ductile iron, the Shaw process and the Parlanti process —were developed abroad.

Some of the subjects that require further fundamental study, according to Lownie's estimate are:

1. Viscosity, surface tension and flow of liquid metal.
2. Thermodynamics of melting.
3. Mechanism of solidification.
4. Interactions between metals and molds.
5. Alloying.

The meaning of the meeting was clear to many of the foundrymen attending. Even though gray iron is a basic material, unless it begins to compete with some of the newer engineering materials, its markets will shrink under the force of more aggressive, research conscious competitors.

New Materials, Processes at Metal Show

New materials and engineering processes were featured at the 1960 Metal Show, part of the 42nd National Metal Congress and Exposition held in Philadelphia, Oct 17-21. The congress was sponsored by the American Society for Metals and seven allied societies.

Many engineers told this publication that fresh emphasis on metals, processes and forms made this show "more interesting" than the 1959 show.

Steel Arena sets the pace

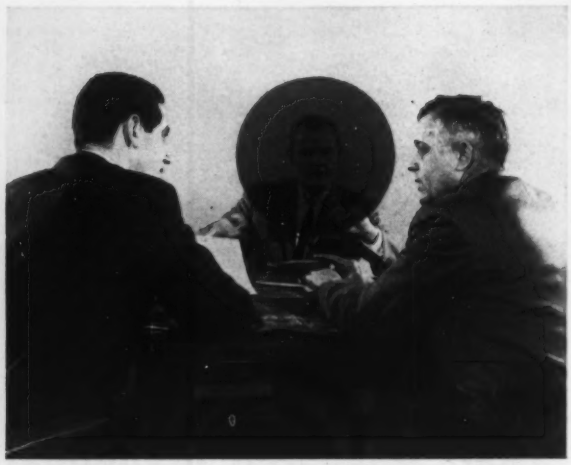
For the first time, steel producers centralized their exhibits in one area. The Steel Arena was the hub and pace-setter for the rest of the show. By staffing their exhibits with technical personnel, the steel companies provided a single, convenient source of information about all phases of steel technology.

Another highlight of exhibits in the Arena was the wide range of new and unique applications for steel in the automotive, aerospace and processing industries.

Among the other exhibits of interest to materials specialists were General Electric Co.'s "fluidized bed" method of heating metals up to 85% more rapidly than has been possible previously; a diffusion coating process, developed by Haynes Stellite Co. to improve oxidation resistance of nickel, cobalt and iron parts; and a new alloy manufactured by Wilbur B. Driver Co. for bonding and sealing high alumina ceramics to metals.

Army Day highlighted meetings

Notable among the technical meetings was Army Day, sponsored by the American Institute



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of Mining, Metallurgical and Petroleum Engineers.

In his review of the role of metals in defense, J. R. Townsend, Special Assistant to the Director of Defense, stressed the need for drastic cuts in the lag between a scientific discovery and its useful engineering application.

Mr. Townsend also reviewed the Defense Dept.'s programs for materials education and research in universities and the current plans to establish a technical evaluation center for ceramics similar to those now organized for metals and plastics.

Metal composites for bearings, reactors

In another meeting, improved metal-bonded graphite materials that combine the metal's strength with graphite's anti-friction properties were described by Dr. M. Humenik, Jr. of Ford Motor Co. Addition of powdered calcium-silicon alloy during liquid-phase sintering of graphite with iron, nickel, cobalt, copper, silver or aluminum overcomes the usual incompatibility of the liquid metals and graphite.

Powder-produced uranium carbide is a promising nuclear fuel material according to H. S. Kalish, Olin Mathieson Chemical Corp. The carbide has a high uranium atom concentration and good thermal conductivity.

Materials for Space Discussed

Foamed plastic cocoons for astronauts, an improved vacuum bag molding technique for producing glass cloth laminate, and the use of urethane resins for structural laminates are three new developments in plastics becoming important in space technology.

They were among the topics covered in a materials symposium sponsored in late October by the Delaware Valley Chapter of the Society of Aerospace Material & Process Engineers. The meeting was held in Philadelphia.

Foamed protective structures

According to H. R. Moore, Naval Air Development Center, one-component urethane foam systems show promise for space applications such as protective enclosures for astronauts and space stations. His paper described newly developed compositions that could be transported in frozen form to space station locations, then heated to produce dense foamed structures.

New data on urethane resins for structural laminates were presented by A. P. Bonanni, Naval Air Material Center. Comparison of the newly developed formulations with conventional polyester and epoxy laminates showed the urethanes have superior flexural strength at room temperatures even after 30 days immersion in water.

Laminated helicopter blades

Two papers discussed new processes and designs for helicopter blades:

1. G. A. Zerby, Vertol Div. of Boeing Airplane Co., described a simple frame and fixture for vacuum bag molding of glass cloth laminates.

2. J. R. David, Dama Plastics Inc., described a process for producing blades with a urethane foam core reinforced with a metal strip and covered with a prepreg epoxy laminate.

Hardenable titanium alloy

New performance data on B120-VCA age hardenable titanium beta alloy was presented by P. J. Soltis, Naval Air Material Center. He said this alloy can achieve ultimate strengths of 200,000 psi through proper solution treatments, and thus compares favorably with precipitation hardening stainless steels on a strength-to-weight basis.

News of Societies

American Society of Industrial Designers has elected the following 1960-61 officers: president—Raymond Spilman, Raymond Spilman Industrial Design; vice president—William C. Renwick, Renwick, Thomson & Grove; secretary—Clarence F. Graser, International Business Machines Corp.; and treasurer — George Levaughn, Henry Dreyfuss Co.

American Society for Metals has elected the following 1960-61 officers: president—Dr. W. A. Pennington, University of Maryland; vice president — Dr. E. Swartz, Consultant; secretary—M. A. Schell, A. O. Smith Corp. The Society also presented the following awards at the 42nd National Metal Congress: William Hunt Eisenman Award—H. B. Knowlton, retired, International Harvester Co.; Gold Medal—J. B. Johnson, Aeronautical Research Laboratory; Henry Marion Howe Medal—Dr. J. B. Clark, Dow Chemical Co., and Dr. F. N Rhines, University of Florida; Medal for Advancement of Research—Dr. E. W. Engstrom, RCA; Albert Sauveur Achievement Award—Dr. B. Chalmers, Harvard University; Bradley Stoughton Award—Dr. H. W. Paxton, Carnegie Inst. of Technology; and the Albert Easton White Award—Dr. C. H. Mathewson, Professor Emeritus, Yale University.

Metallurgical Society, American Inst. of Mining, Metallurgical, and Petroleum Engineers, has announced the following 1961 officers: president—J. S. Smart, Jr., American Smelting & Refining Co.; vice president and president elect—Karl L. Fetters, Youngstown Sheet & Tube Co.

Pressed Metal Institute has awarded Clement C. Caditz of Northern Metal Products Co. the Presteel Award for a substantial contribution to enlarging the field of metal stampings.

Society of Plastics Engineers, Inc. will publish a new quarterly scientific journal *SPE Transactions,* starting next month. It will contain articles on basic polymer theory, science and engineering.

Coming Meetings on p 31 ⟶

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MINIMUM LUBRICATION REQUIRED—Because of the controlled porosity and non-melting nature of GRAPHITAR, the only lubricant GRAPHITAR bearings need is water or other low-viscosity fluid. Any such fluid with non-gumming characteristics will provide an extremely low coefficient of friction and assure long life of the GRAPHITAR parts.

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News of Industry

Coming Meetings

ATOMIC INDUSTRIAL FORUM AND AMERICAN NUCLEAR SOCIETY. San Francisco. Dec 12-15.

7TH NATIONAL SYMPOSIUM ON RELIABILITY AND QUALITY CONTROL, sponsored by ASQC, AIEE, IRE & EIA. Philadelphia. Jan 9-11.

SOCIETY OF AUTOMOTIVE ENGINEERS, INC., International Congress & Exposition. Detroit. Jan 9-13.

3RD MECHANICAL WORKING CONFERENCE, "Bar & Shaped Products," American Institute of Mechanical Engineers. Pittsburgh. Jan 18.

SOCIETY OF PLASTICS ENGINEERS, 17th annual technical conference, Baltimore-Washington Sec. Washington. Jan 24-27.

AMERICAN SOCIETY FOR TESTING MATERIALS, committee week. Cincinnati. Jan 30-Feb 3.

SOCIETY OF THE PLASTICS INDUSTRY, INC., 16th Reinforced Plastics Div. Conference. Chicago. Feb 7-9.

AMERICAN INSTITUTE OF MINING, METALLURGICAL & PETROLEUM ENGINEERS, annual meeting. St. Louis. Feb 19-23.

AMERICAN INSTITUTE OF MECHANICAL ENGINEERS, annual meeting. St. Louis. Feb 26-Mar 2.

GAS TURBINE POWER CONFERENCE & EXHIBIT, American Society of Mechanical Engineers, Washington, D.C. Mar 5-9.

STEEL FOUNDERS' SOCIETY OF AMERICA, 59th annual meeting. Chicago. Mar 11-14.

AVIATION CONFERENCE, American Society of Mechanical Engineers. Los Angeles. Mar 12-16.

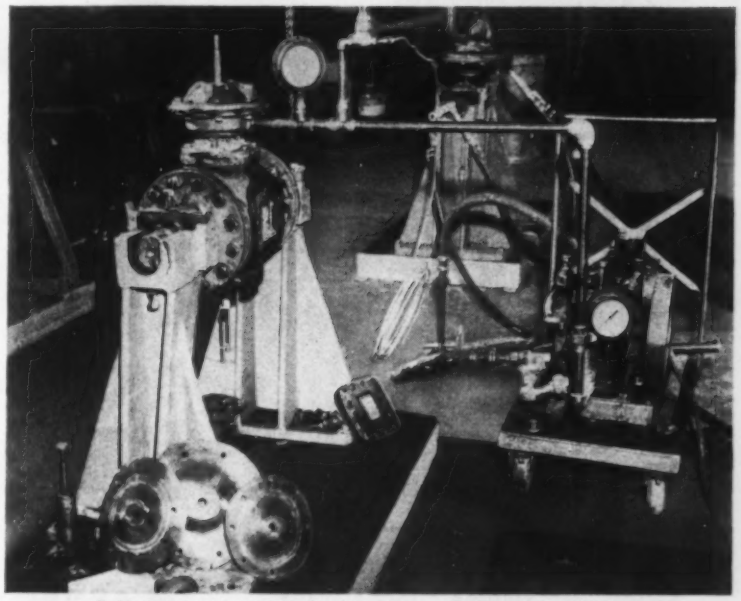
TEXTILE ENGINEERING CONFERENCE, American Society of Mechanical Engineers. Clemson, S. C. Mar 16-17.

AMERICAN SOCIETY FOR METALS, 12th Western Metal Congress & Exposition. Los Angeles. Mar 20-24.

AMERICAN CHEMICAL SOCIETY, 139th national meeting. St. Louis. Mar 21-30.

PRESSED METAL INSTITUTE, spring technical meeting. Cleveland. Mar 22-24.

DIAPHRAGM OF REEVECOTE WITHSTANDS 23,520 LB. THRUST IN SAFETY TEST



Safety tests for gas regulator diaphragms are run by Reynolds on this device fed by a hydraulic pump. Here, on an effective area of 24 sq. in., a Reevecote synthetic diaphragm safely absorbed a total thrust of 23,520 lbs.

The Reynolds Gas Regulator Co., of Anderson, Ind., takes unusual safety precautions to check the tensile strength of diaphragms in their gas regulators.

Some of their diaphragms must absorb sudden surges in pressure—up to 1000 psi. That's why Reynolds runs special safety tests on the diaphragms.

The results of these tests prove the outstanding superiority of diaphragms made of Reevecote.

In a recent test at Reynolds, Reevecote 7270, 0.093" gauge a Buna-N coated nylon, successfully withstood 980 psi on an effective diameter of 24 sq. in.—or a total thrust of 23,520 pounds.

Reevecote diaphragms are flexible and sensitive, yet tough enough to stand up safely under severe extremes of pressure.

If your design calls for the use of diaphragms, or coated fabrics—choose from the most complete source of coated fabrics for industry—REEVECOTE.

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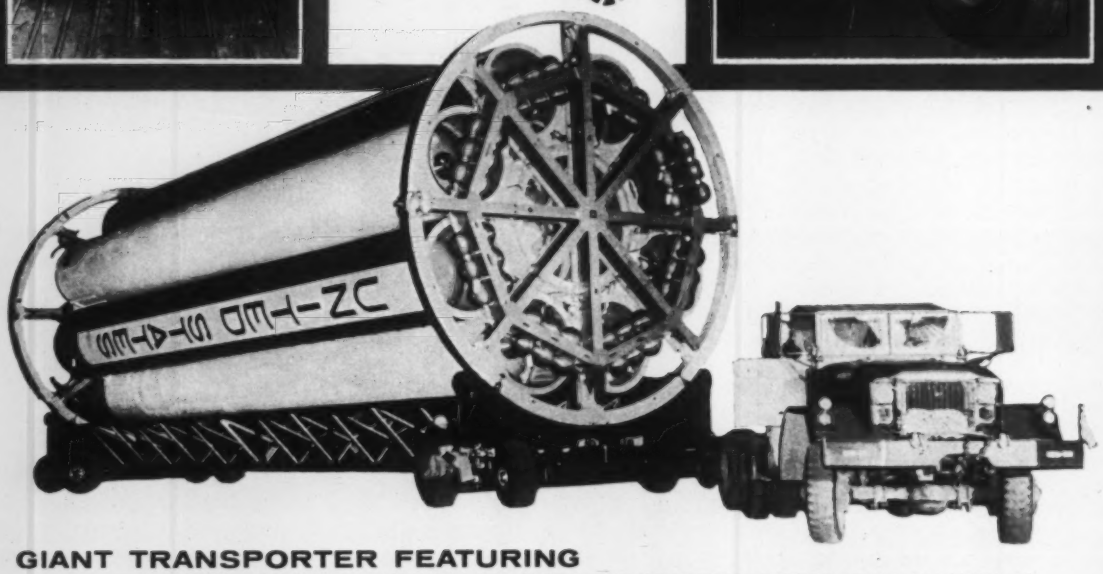

GIANT TRANSPORTER FEATURING ACIPCO "WALKING BEAM ASSEMBLIES" WILL HELP...

Saturn's conquest of space

The moment draws near when America's Saturn rocket will thunder into space. But in the meantime, elaborate ground preparations are now taking place.

From the N.A.S.A. Marshall Space Flight Center in Huntsville, Alabama, via a circuitous land and water route to the launching site, the missile and its valuable cargo will be gently cradled on the huge transporter shown here. Acipco walking beam assemblies (upper left) are vital parts of this transporter.

These rugged assemblies are constructed of high strength alloy steel and comprise centrifugally spun and statically cast component parts . . . all produced at Acipco. Also, all precision machining and intricate fabrication work were done by skilled Acipco personnel.

While your tubular product application may not be destined for outer space, Acipco's production "know how" and complete "under one roof" facilities can assist you, too. Your inquiry is invited.

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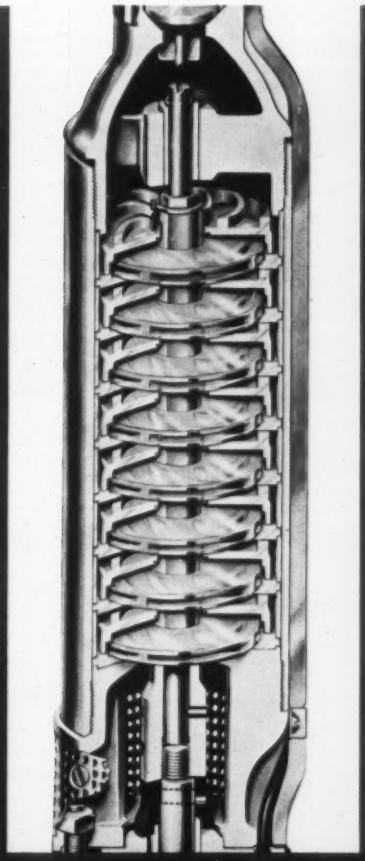

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Lexan's exceptional combination of properties includes:

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- High strength at low temperatures
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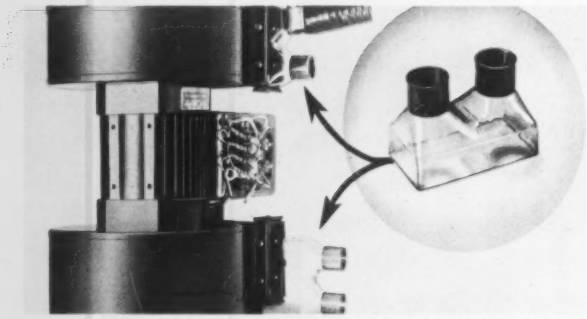
NOW TWO GENERAL ELECTRIC GIVE YOU LEXAN THERMOPLASTICS

HOUSINGS OF LEXAN thermoplastic protect riding lights on the trailing edges of Lockheed's F-104 Starfighter. The transparent resin withstands high friction caused by speeds of 1500 mph, thanks to its exceptional resistance to wear and heat. The material can take high-altitude cold. (Housings molded by Crescent Mold Engineering Corp., N. Hollywood, Calif.)



BLOWER COUPLINGS for radar unit are tough, flame-resistant . . . give smoother air flow than could formerly be obtained with brass fittings. Fabricated of LEXAN polycarbonate resin, they withstand cycling from −54°C to +54°C under humid conditions. They are inexpensively vacuum-formed, allowing considerable savings in machining costs. (Used by the Tracking and Acquisition Radar Equipment Section of General Electric Company, Syracuse, N. Y.)

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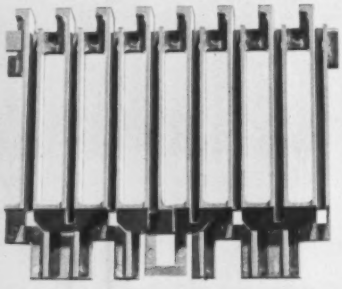
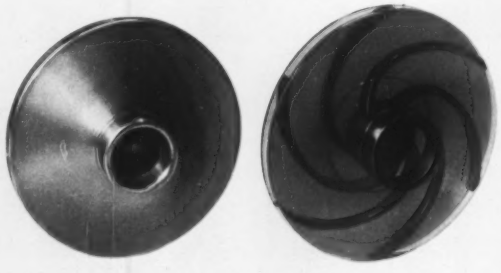
Pioneer in polycarbonates, G.E. has cooperated in the use of LEXAN resin in over 300 commercial applications. You can draw on this experience through G-E Technical Service. For a complete rundown on properties, uses, design considerations, molding and fabricating tips – send for LEXAN technical literature—the most complete literature on polycarbonates available! (*Coupon on page after next.*)

LEXAN—for designs that demand exceptional properties. If you want high strength and heat stability in a thermoplastic, use LEXAN polycarbonate resin. So tough is this material that it can actually be cold-formed and coined like a metal. It withstands over 12 foot-pounds per inch of notch—an impact strength attained by no other plastic. At the same time, LEXAN resin gives you a heat distortion point as high as 290°F! These properties are combined with outstanding dimensional stability, low water absorption, good electrical characteristics and other advantages.

LEXAN resin can be injection molded, extruded, vacuum formed, machined and bonded. It can be made into high-precision moldings, sheet, rod, tube, filament.

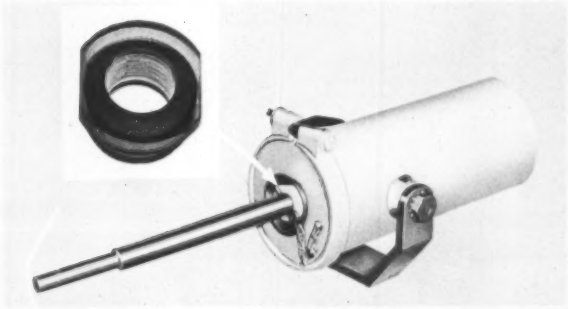


CARD GUIDE requires molding to close tolerances and minimum change in dimensions during service. Molded of LEXAN resin, the part shows excellent dimensional stability under varying conditions of moisture and at high temperatures. LEXAN resin is self-extinguishing—important in this application. (Molded for International Business Machines Corp. by Consolidated Molded Products Corp., Scranton, Pa. and Quinn-Berry Corp., Erie, Pa.)

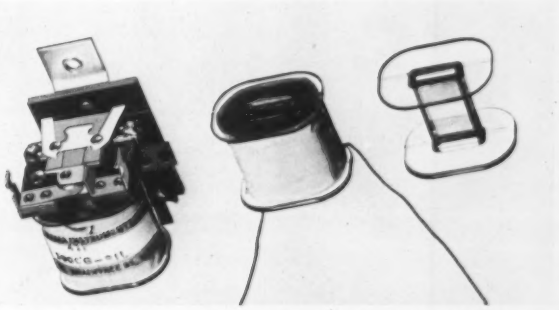


IMPELLERS molded of LEXAN resin replace bronze in jet pumps. Outperforming metal, LEXAN resin gives exceptional impact strength plus ability to withstand 280°F without distorting. LEXAN impellers withstant abrasive wear better than bronze and are unaffected by water or dilute acid. Impeller halves can be separately molded and then solvent-cemented. (Molded for Sta-Rite Products, Inc., Delavan, Wis. by Modern Plastics Corp., Benton Harbor, Michigan, and Santay Corp., Chicago, Ill.)

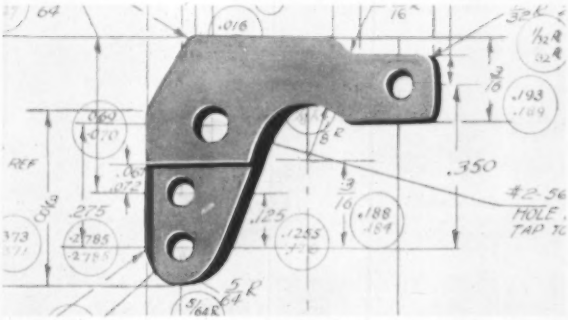
POLYCARBONATE PLANTS TO SOLVE PROBLEMS LIKE THESE



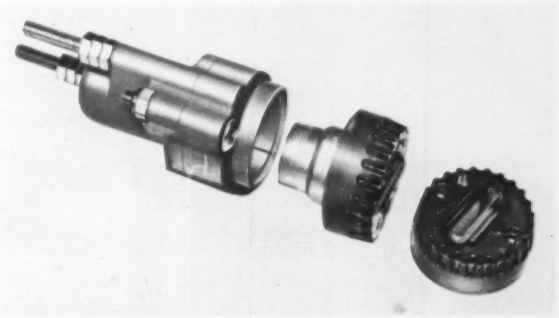
EMERGENCY-BRAKE BUSHINGS of LEXAN resin help trucks come to a safe stop. Before LEXAN bushings were used, the hole for the piston at the end of the activating cylinder quickly wore oblong, allowing road dirt to enter and cause leakage of the inner seal. The plastic's resistance to wear, heat and grease makes it ideal for this critical use. (Brake manufactured by MGM Brakes, Inc., Cloverdale, Calif. Bushings by Automatic Plastic Molding Co., Berkeley, Calif.)



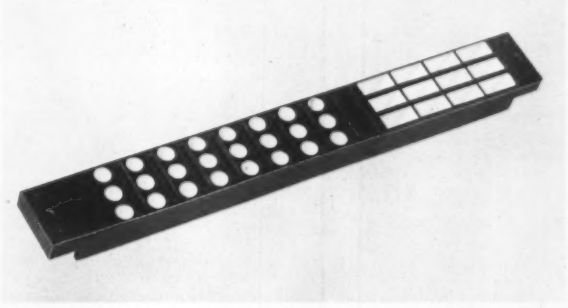
COIL FORM must not distort at temperature above 200°F under stresses caused by tightly wound wire. LEXAN resin provides heat distortion temperatures of 280-290°F under load. A good dielectric, LEXAN resin is resistant to oxidation at high temperatures and is non-corrosive even when used with very fine Class F magnet wire. (Molded for Sigma Instruments, Inc., So. Braintree, Mass. by Waterbury Companies, Inc., Waterbury, Conn.)



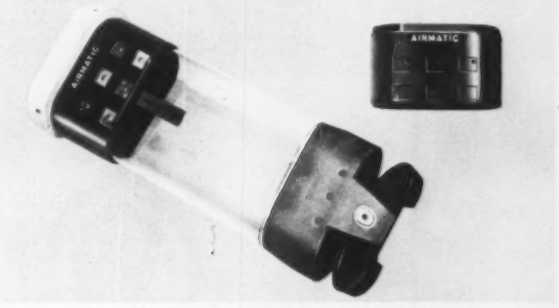
INSULATOR BLOCK of LEXAN resin helps insure trouble-free performance of electrical counter. Not much bigger than a dime, the part must maintain severe tolerances. It takes −85° to +280°F without distortion. The dimensional stability of LEXAN resin lowers cost of the part, permits replacement of materials which required costly machining to attain accurate dimensions. (Molded by Fred Knapp Engraving Co., Racine, Wis., for Abrams Instrument Corp., Lansing, Mich.)



FUSE HOLDER CAPS make use of the transparency and heat resistance of LEXAN polycarbonate resin. Lamp shining through LEXAN cover indicates blown fuse. Plastics previously used softened under the high temperature encountered in naval equipment. LEXAN resin was also selected for its good dielectric properties in the holder, which is rated up to 600 volts and 60 amps. (Molded by B&B Plastics, Oakville, Conn. and Engineered Plastics, Inc., Watertown, Conn. for Fuse Indicator Corp., Boston, Mass.)



LAMPHOLDER TERMINAL BLOCK is used inside electronic equipment where heat is difficult to dissipate. LEXAN polycarbonate resin replaced another thermoplastic which melted under severe thermal conditions. The part is molded with black resin and painted white in the lampholder holes. (Molded by Booker & Wallestad, Minneapolis, Minn. for Remington Rand Univac Div. of Sperry Rand Corp., St. Paul, Minn.)



"WARHEADS" for pneumatic tube systems take advantage of the high impact strength and dimensional stability of LEXAN resin. The good electrical properties of the thermoplastic permit placement of all electrical control elements in the head. LEXAN resin resists wear and tear and saves cost of repair and replacement in these parts, which undergo friction at speeds as high as 20 mph. (Molded for Airmatic Systems Corp., Saddle Brook, N. J. by Berkeley Engineering and Manufacturing Co., Berkeley Heights, N. J.)

PROPERTIES OF LEXAN POLYCARBONATE RESIN

PHYSICAL PROPERTIES

Property	Value	A.S.T.M. Test
Color	Light amber, transparent	—
Specific gravity	1.20	D 792
Odor	None	—
Taste	None	—
Refractive index at 25°C	1.586	—
Rockwell hardness	M70, R118	D 785
Abrasion resistance, Taber abraser with CS-17 wheel	7–11 mg/1000 cycles	D 1044
Impact strength, notched Izod, ⅛" specimen	12–16 ft-lb/in. of notch	D 256
Impact strength, unnotched Izod, ⅛" specimen	>60 ft-lb/in.	D 256
Tensile-impact	600–900 ft-lb/cu in.	—
Tensile yield strength	8,000–9,000 psi	D 638
Tensile ultimate strength	9,000–10,500 psi	D 638
Tensile modulus	320,000 psi	D 638
Elongation	60–100%	D 638
Compressive strength	11,000 psi	D 695
Compressive modulus	240,000 psi	D 695
Flexural strength	11,000–13,000 psi	D 790
Flexural modulus	375,000 psi	D 695
Shear yield strength	5,400 psi	D 732
Shear ultimate strength	9,200 psi	D 732
Light transmission (⅛ in. thick disc)	75–85%	—
Water vapor permeability	$3–4 \times 10^{-8}$ g/cm/hr/cm²/mm Hg	—
Nitrogen permeability	0.012×10^{-8} cc(STP)/mm/sec/cm²/cm Hg	—
Carbon dioxide permeability	0.32×10^{-8} cc(STP)/mm/sec/cm²/cm Hg	—
Bulk factor of pellets	1.7	—
Poisson's ratio	0.38	—
Modulus of rigidity	116,000 psi	—
Deformation under load, 4000 psi 77°F	0.2%	D 621
158°F	0.3%	
Fatigue endurance limit (Wohler method), 1800 cycles/min., 73°F, 50% RH	2000 psi	
Water absorption, 24 hr. immersion	0.2%	D 570
equilibrium 73°F	0.35%	
equilibrium 212°F	0.58%	

THERMAL PROPERTIES

Property	Value	A.S.T.M. Test
Heat distortion temperature	264 psi: 280°–290°F 66 psi: 283°–293°F	D 648
Mold shrinkage	0.005–0.007 in./in.	D 955
Thermal conductivity	4.6×10^{-4} cal/sec/cm²/°C/cm	—
Coefficient of linear thermal expansion	3.9×10^{-5} in./in./°F	D 696
Flammability	Self-extinguishing	D 635
Brittle temperature	<−135°C	D 746
Specific heat	0.30	Bulletin 157

Deformation under load on 0.5 in. cube	Temp., °F	Load, lb	Deformation, %	A.S.T.M. Test
	158	1000	0.282	D 621
	158	500	0.080	
	77	1000	0.220	
	77	500	0.101	

ELECTRICAL PROPERTIES

	−30°C	−3°C	23°C	100°C	125°C	A.S.T.M. Test
Dielectric constant						
60 cycles	3.12	3.14	3.17	3.15	3.13	D 150
10^6 cycles			2.96			D 150
Power Factor						
60 cycles	0.005	0.004	0.0009	0.0009	0.0011	D 150
10^6 cycles			0.010			D 150
Volume resistivity, ohm-cm	$>10^{17}$	$>10^{17}$	2.1×10^{16}	2.1×10^{15}	2.7×10^{14}	—
Arc resistance,						D 495
stainless steel strip electrodes			10–11 sec			
tungsten electrodes			120 sec			

	25°C	100°C	A.S.T.M. Test
Dielectric strength, short time	3,910 v./mil at 1.5 mils 3,080 v./mil at 3.0 mils 2,560 v./mil at 4.7 mils 1,130 v./mil at 23.0 mils 400* v./mil at 125.0 mils	3,380 v./mil at 3.0 mils 1,250 v./mil at 23.0 mils 600* v./mil at 125.0 mils	D 149
Resistance to electron beam radiation	No change up to 5×10^7 r dosage		

(*The step-by-step values are essentially the same as the short time values for the 125-mil pieces)

Chemical Materials Department, Section M-2
General Electric Company, Pittsfield, Mass.

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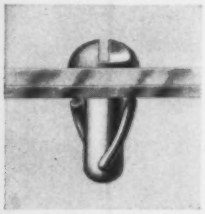

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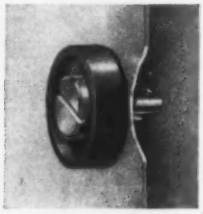

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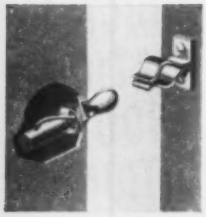

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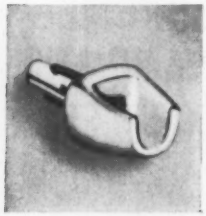

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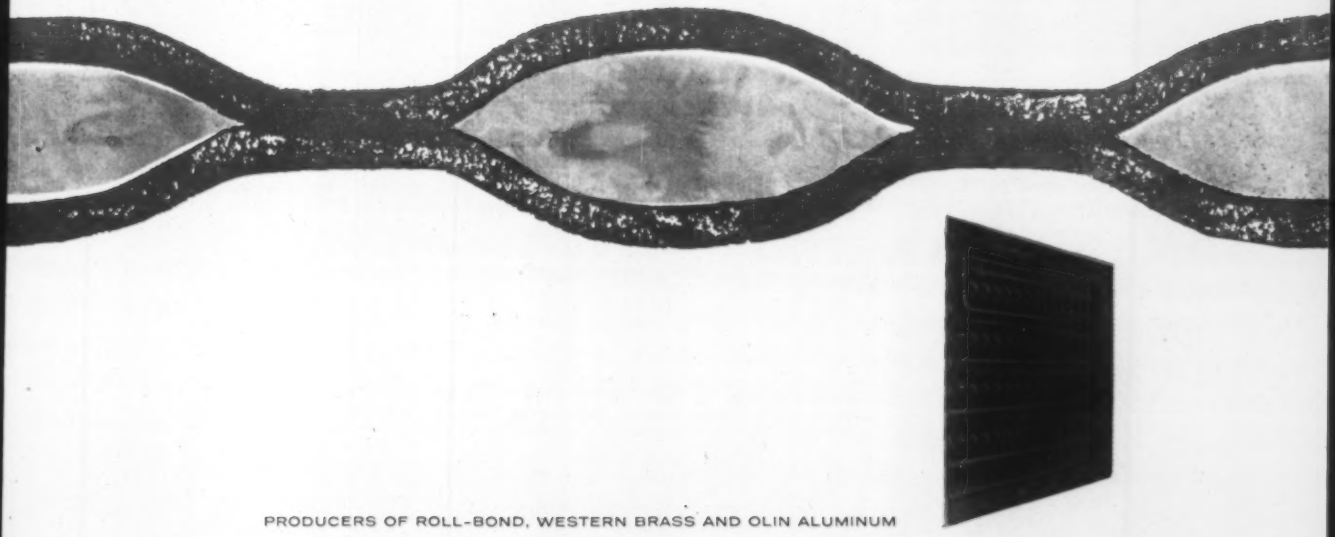

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IMPACT STRENGTH	43 ft.-lb.*	2.0 ft.-lb.	1.4 ft.-lb.
SHEAR STRENGTH	31,000 p.s.i.	25,000 p.s.i.	9,510 p.s.i.
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Take advantage of R/M's more than 20 years of experience in the production of bonded assemblies and the manufacture of adhesives, coatings and sealers. Why not call on Raybestos-Manhattan engineers today, without obligation, and ask them to prove how they can help you cut costs, speed production, and simplify fabrication and assembly operations.

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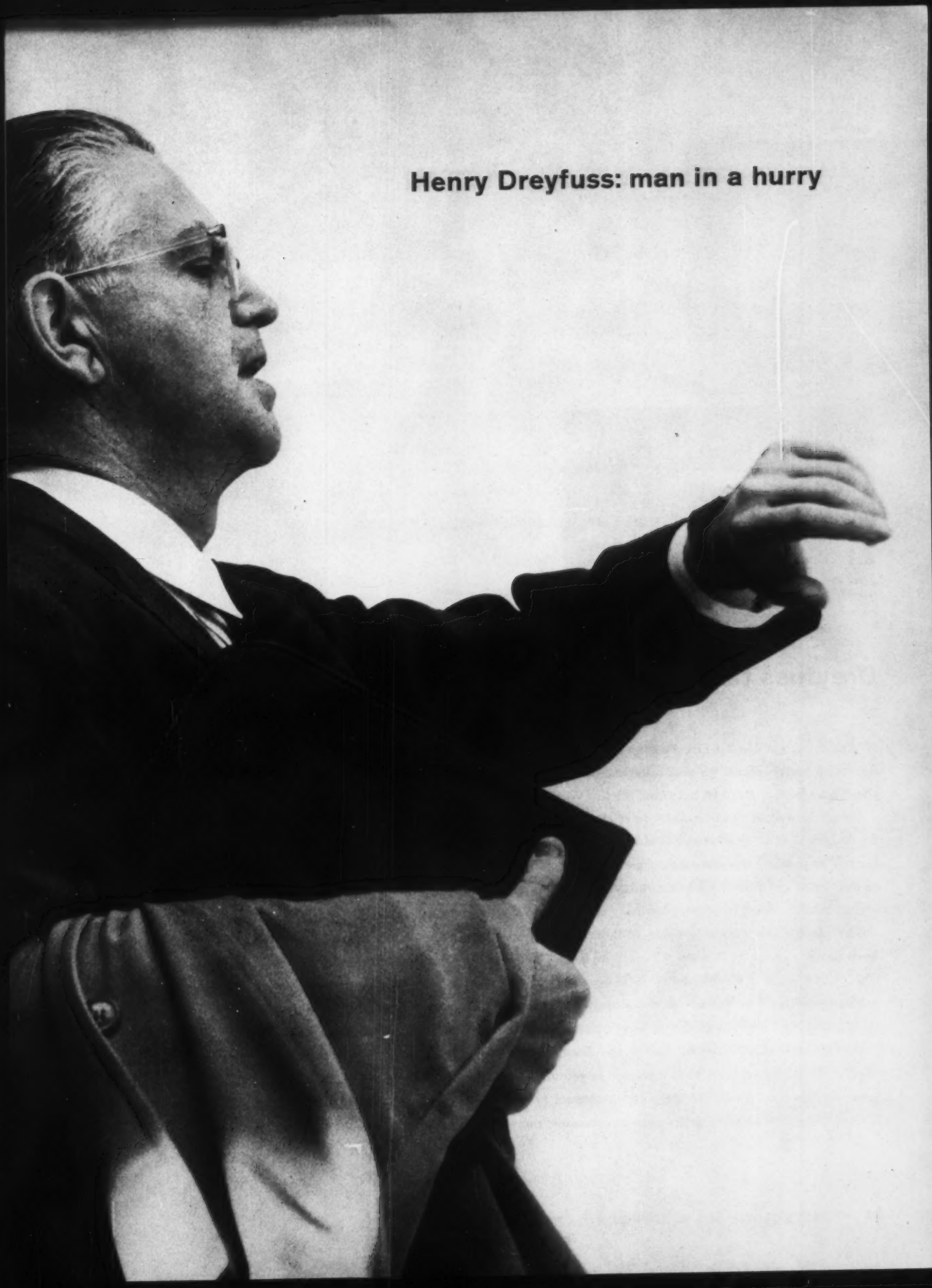
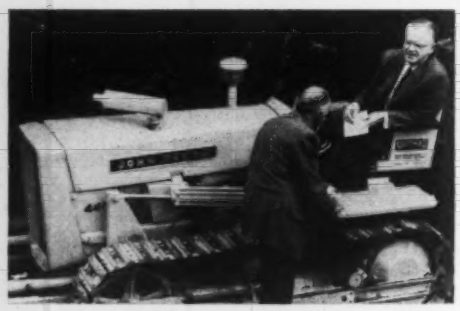

Henry Dreyfuss: man in a hurry



Dreyfuss talks design

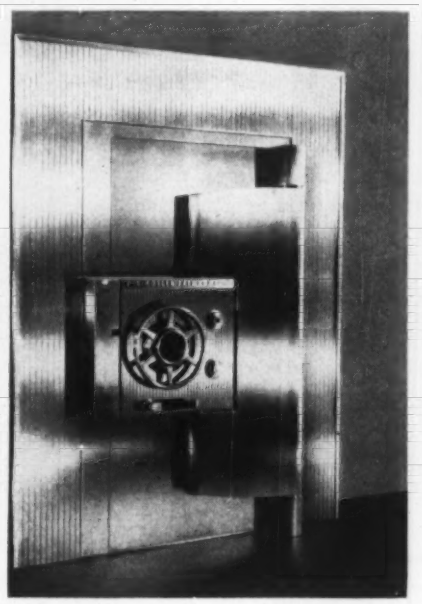
If you could get Henry Dreyfuss to sit still long enough for a caricature, the drawing would inevitably show him with his coat half on and briefcase in hand. Most likely, he would be on his way to the airport. He's on the East Coast a third of his time, on the West Coast a third, and the other third in between.

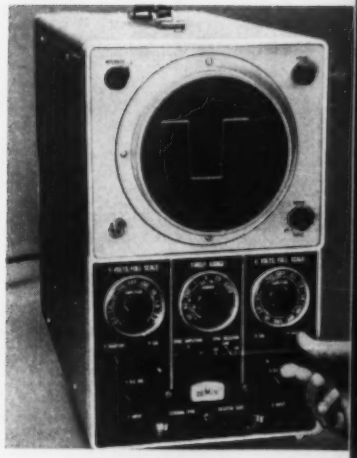
Henry Dreyfuss has been busy ever since he gave up scenery design in the late Twenties and helped pioneer the business that is now called industrial design. In the early days, he gave a new look to everything from hinges to pianos, cigarette lighters to tractors. Today he can look back on a career of redesigning vacuum cleaners and gas stations, bowling alleys and ship interiors, typewriters and dental equipment, magazine formats and military strategy rooms, plumbing fixtures and the Nike missile launcher.

But Henry Dreyfuss is not one to look back. There are designs on his boards today that will influence our lives twenty years from now. "Time," he says, "is one of the designer's big problems. A design assignment is often three years in development. The item may not be on the market for another three to ten years. After it's introduced it will be in use for any number of years. In order to design that far ahead, our ideas have to be fresh, advanced and sprightly. It is a challenge to have to think as far ahead as we do."

One thing that goes a long way is the Henry Dreyfuss design credo, and it is all about people. "It says in effect," Dreyfuss states, "that the item is going to be ridden in, sat on, looked at, talked into, operated or in some way used by people. If the point of contact between the product and people causes friction, we have failed.

"On the other hand, if people are made safer, more comfortable, more eager to purchase, more efficient, or





just plain happier—we have succeeded." And succeed Dreyfuss does, by following this yardstick for effective industrial design: 1. Safety and convenience of use. 2. Ease of maintenance. 3. Cost, including tooling, production and distribution. 4. Sales appeal. 5. Appearance.

Selection of the right material for the job plays an important role in satisfying each of the five requirements. As a matter of ethics and sheer common sense, Henry Dreyfuss, like any member of the American Society of Industrial Designers, will not endorse any one material. "We have worked with all materials. What we want is the material that is right for the job. We look for the material that combines reasonable cost with the ability to be fabricated economically, and at the same time will give the product the built-in quality and durability it needs to sell well." With no-nonsense requirements like that, it is not surprising that a great many Dreyfuss-designed products use steel in one way or another.

Steel has strength, integrity and honesty. Steel is what the designer is apt to call a 'natural.' Dreyfuss feels that the public's image of steel depends largely on the product itself. A massive steel vault door conjures up an image of strength, imperviousness. Stainless Steel tableware suggests style and modernity. Steel curtain wall panels give buildings the look of tomorrow.

The moral is this: steel has been with us for ages, yet it is the modern metal, the metal of the future. Its enduring modernity will continue to be recognized, and used, by designers like Henry Dreyfuss.

(turn the page for a new look at steel)

USS TRADEMARK **United States Steel**

designing with USS High Strength Steels

Good design goes beyond material selection. Once the choice has been made, the designer's job is to take full advantage of the material's properties. Few materials offer designers as much opportunity as high strength steels.

COR-TEN Steel was developed by U.S. Steel and first used in 1933.

USS COR-TEN Steel is a name that has become a byword in design circles. It is a time-tested, high-strength low-alloy steel. Structural designers welcomed COR-TEN Steel because it allowed them to pare dead weight and to lower maintenance costs. As structures, mobile equipment and machinery got bigger and bigger, dead weight became more of a problem. Even when weight could be shaved without stress problems, durability suffered. This high strength steel answered both problems.

Dead weight in stationary structures is costly; in mobile equipment dead weight requires more power to move.

USS High Strength Steels' yield points are all 50,000 psi min. compared to 33,000 psi for structural carbon steel.

Strength did it. COR-TEN brand and other USS High Strength Steels have a 50% higher yield point than structural carbon steel. They permit as much as 33% weight reduction. They have superior resistance to atmospheric corrosion and abrasion, so there is little reason to overdesign. Their fatigue and impact properties are excellent. Here is a quick look at three well-known USS High Strength Steels:

Send for the manual described at the right for a comprehensive guide on how to design with high strength steels.

USS COR-TEN Steel has a yield point 50% greater than structural carbon steel, has four to six times its resistance to atmospheric corrosion. It is used to do any one of these three things: 1) in slimmer sections to cut weight at no strength loss; 2) in equal sections to increase load-carrying capacity, cut maintenance and lengthen life; and 3) any number of combinations of 1 and 2. COR-TEN Steel also has greatly superior paint adherence and is used where a longer interval between repainting is wanted.

USS TRI-TEN Steel, with its 50% higher yield point than structural carbon steel, has superior notch toughness at low temperatures and keeps rugged equipment operating even in sub-zero weather. Its high endurance limit makes TRI-TEN Steel ideal for mobile equipment that must take repeated loading and reversals of stress. It is a natural for welded structures and bridges.

MAN-TEN Steel costs only about 20% more than structural carbon steel; TRI-TEN Steel about 36% more, and COR-TEN Steel 42% more.

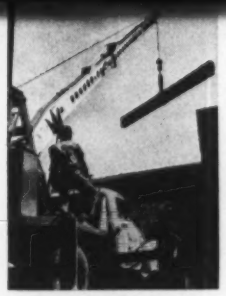
USS MAN-TEN Steel also has a 50% higher yield point than structural carbon steel, and is the low-cost member of the family. Weight reduction as little as 17% with MAN-TEN Steel will save money on material cost alone. MAN-TEN Steel is a tough, durable steel and widely used in earthmoving equipment, truck frames, material handling apparatus and riveted bridges.

High strength steels represent but a few of the over 3000 grades of steel in existence today. United States Steel makes a complete line of high strength steels, as well as constructional alloy, stainless and carbon steels. Bring your design problems to us. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

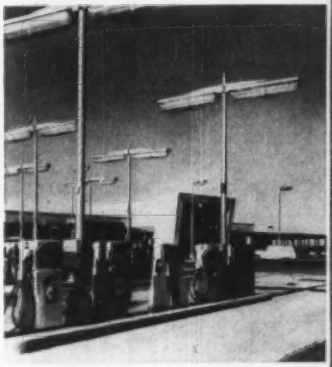
USS, COR-TEN, MAN-TEN and TRI-TEN are registered trademarks.

Watch United States Steel's special Christmas show, **The Coming of Christ**, in Color on NBC-TV, Wednesday, December 21, 8:30 P.M., E.S.T.

USS **United States Steel**



Cranes have to operate in all-weather temperatures and are subject to stress and shock. That's why many of them are made of tough TRI-TEN Steel.

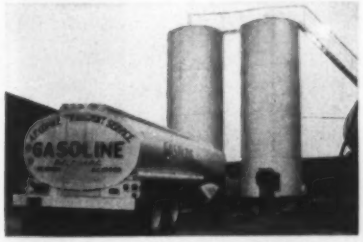


Light standards stay good looking for years because of COR-TEN Steel's outstanding atmospheric corrosion resistance. Paint life is extended. Slim design is made possible by COR-TEN Steel's strength.

TRI-TEN Steel has cut weight and cost of dozens of major bridges. In the bridge shown here, TRI-TEN Steel saved a quarter of a million dollars.

One of the first applications of COR-TEN Steel was in hopper cars for weight reduction and longer life. Today, use of COR-TEN Steel can save hundreds of dollars over the life of a car.

MAN-TEN Steel, used in truck frames and body members, reduces dead weight and increases payload.



The LPG cylinder business uses considerable amounts of MAN-TEN Steel because of its strength, cost and ease of fabrication to lighten the weight.

This mark tells you a product is made of modern, dependable Steel.

Here's a book that is in the hands of thousands of engineers and designers. It is your guide to the design of lighter, stronger equipment and structures.

design manual for high strength steels

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United States Steel
Room 6150
525 William Penn Place
Pittsburgh 30, Pa.

Please send me "Design Manual for High Strength Steels"

Name _____

Title _____

Company _____

Address _____

City _____ Zone ____ State _____

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DOW

NEWS ABOUT PRODUCT DESIGN AND MATERIALS

Win the housewife's approval . . . and products designed for the home score success in the marketplace. By helping designers create colorful, durable products that are effortless to care for, easy to use . . . modern plastics assist in gaining the all-important nod of approval from the lady of the house. In these new products, for example . . .

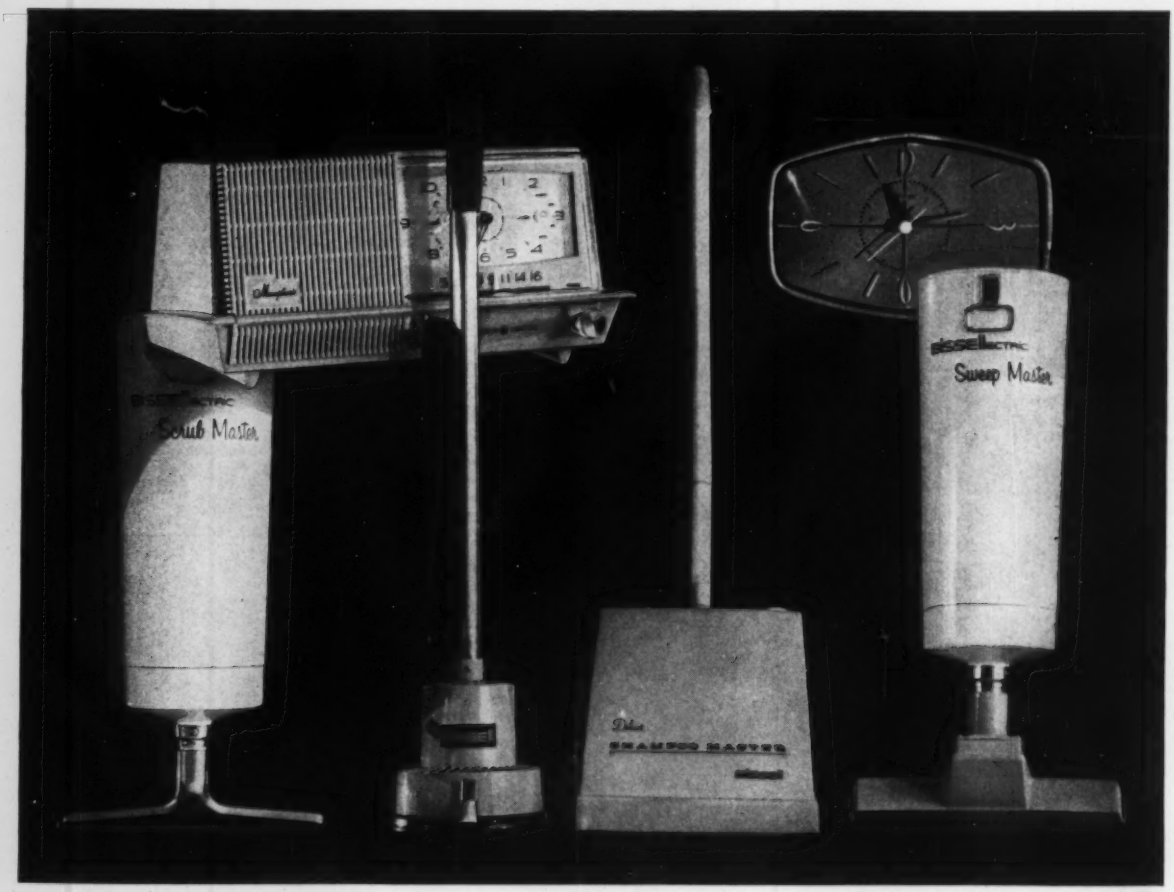
TODAY'S PLASTICS STAR IN NEW HOUSEWARE DESIGNS

Whether the design is a new product or improvements for an old standard, Dow plastics are ready to help the designer. They provide a vast array of thermoplastics formulations—each with particular specialties. Take Styron®, for example . . .

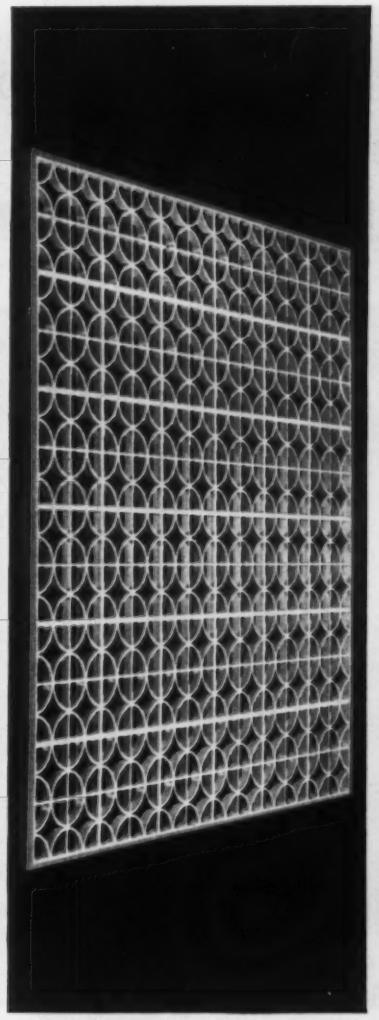
The workhorse of modern plastics, Styron (Dow polystyrene) permits the designer complete color choice, with attractive surface finish assured. This material affords good flexural strength—provides excellent dielectric properties and low water absorption. Best of all, Styron is low in cost—molds, extrudes and thermo-forms easily—and is offered in 20 different formulations that spotlight particular design characteristics.

For example, in the new combination appliance designed both to vacuum rugs and scrub floors (illustrated below), tanks are made of Styron 475, developed specifically for high impact strength—three to five times greater than general purpose polystyrene materials. This formulation also provides the tank housing for the hard-working rug shampoo device.

Styron 369, a formulation that combines excellent heat resistance and good impact strength, makes a colorful case for the high-styled clock radio. And the wall clock takes advantage of other versatile features of Styron – the case is opaque while the protective dial cover is crystal clear.



For outdoor relaxation, handsome chairs are laced with cord of PVC, Dow polyvinyl chloride. Excellent aging characteristics, quick recovery from loads combine to assure durability and long-lasting comfort. In a wide range of colors, PVC materials clean easily.



For privacy on the patio, new wall divider grilles offer novel designs, maintain their good looks for years. Molded of Zerlon®, they are exceptionally strong, resist outdoor weathering . . . and stand up under blazing sun or freezing cold.

Cans open in a hurry with electricity turning the crank. And this can opener is a breeze to keep clean because the stand and housing are of Tyril®. Remarkably stain-resistant, this material withstands foods, oils, waxes, soaps . . . even solvents and many chemicals.

LOOKING FOR NEW MATERIALS?

The Dow family of thermoplastics provides one of the widest lines of materials and formulations available in the industry today. More than likely, there are Dow plastics that can help you today in designing products for tomorrow. We'll be glad to help with specialized technical service—from helping select the right formulation to assisting in color styling, as you wish. Just write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Merchandising Department 1721CD12.

THE DOW CHEMICAL COMPANY

Midland, Michigan

DOW

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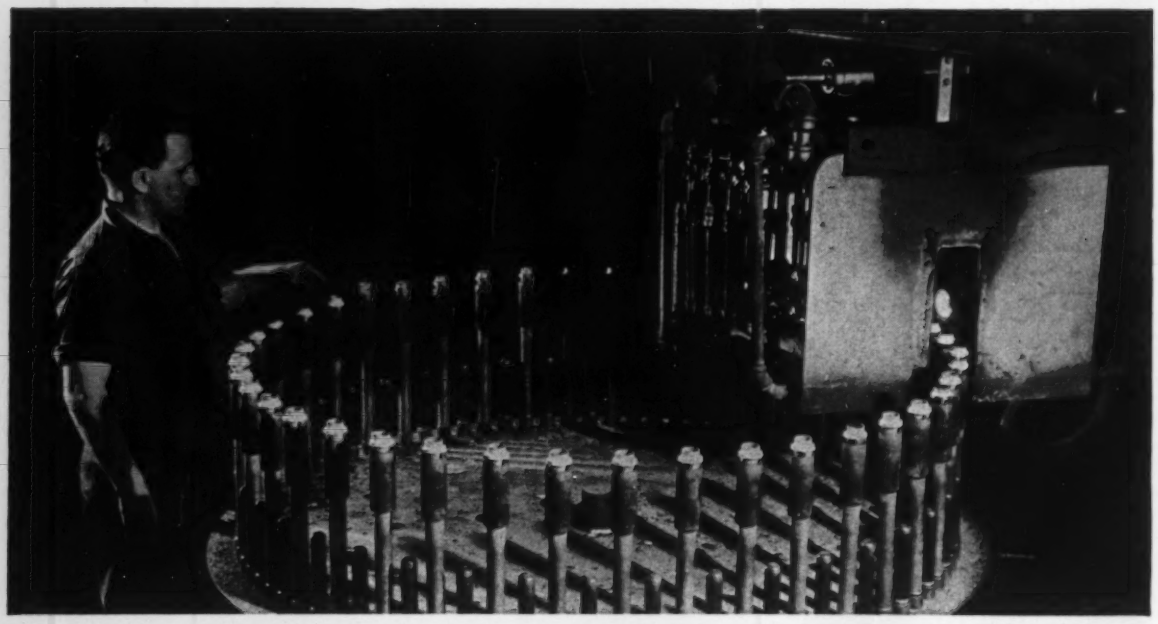
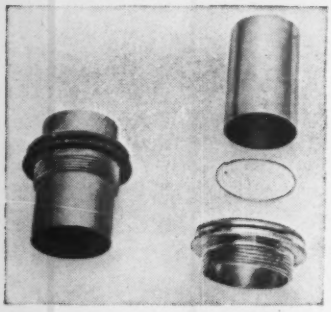
Every Hour M. S. Little Brass Goods Company Makes 650 Appliance Fittings Better With **HANDY & HARMAN SILVER BRAZING**



Rotating jig showing mounted assemblies entering and leaving gas-air furnace.



Left– brazed assembly. Right– components with preform ring of EASY-FLO *45.*

This Hartford, Connecticut, company makes—in volume—an assembly that goes into the overflow system of household appliances. The assembly consists of brass tubing and a machined brass casting. The two components are joined by a preplaced ring of Handy & Harman EASY-FLO 45 silver brazing alloy and HANDY FLUX. Heating is automatic gas-air; parts are placed on a rotating turntable to pass through the gas furnace. Every 60 working minutes, 650 assemblies are completed.

The advantages here are that the manufacturer can use thin-walled tubing with heavier, threaded components at no sacrifice in strength. Because of EASY-FLO's penetrating qualities, the entire shear area is fully as strong as the solid parts of the assembly, yet considerably lighter. And, casting and machining the components for this assembly have been greatly simplified.

Are you in pursuit of a metal-joining method which offers—among other advantages—high, uninterrupted production at low capital investment? You may easily find the answer in Handy & Harman silver brazing. Hundreds of manufacturers and fabricators of as many different products, parts and components are right now enjoying the speed, economy, strength and *flawlessness* of brazing. You can too. Just ask Handy & Harman, 82 Fulton Street, New York 38, N. Y.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

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General Offices: 82 Fulton St., New York 38, N. Y.

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IF IT MUST SLIDE ROLL STRIKE SEAL ...OR DEFY HEAVY LOADS AND ABRASION FROM −80° F. TO +250° F. ... MAKE IT WITH

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URETHANE RUBBER

PROPERTIES OF CURED ADIPRENE POLYMERS					
*Hardness, Shore A	75	88	95	97	99+
Hardness, Shore D	–	43	50	60	78
Modulus, 300%, psi	1100	2100	3200	7000	–
**Tensile Strength at Break, psi	4500	7000	8825	8500	8500
Elongation at Break, %	400	450	480	340	250
Izod Impact Notched ft.-lbs./in.	Flexed	Flexed	Flexed	20	1.2
Split Tear, ASTM-D 470 lbs./linear inch	25	50	155	160	200
***Compression/Deflection, psi @ 5% defl.	250	575	750	1800	6000
Rebound Resilience, %	45	45	40	42	45
Oil Resistance	Good	Excellent	Excellent	Excellent	Excellent
Low Temperature Brittle Point, F.	–80	–80	–80	–80	–80

* Softer compounds ranging from 10 Shore A are also available. ** Samples pulled@ 1 in./minute (elastomer stocks normally pulled@ 20 in./min.) *** Shape Factor—1.0

For more information write E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept., MDE-12, Wilmington 98, Delaware.

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Better Things for Better Living . . . *through Chemistry*

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Liquid flow through a cross section of a Malleable differential carrier.

For Performance-Tested Dependability... Use Malleable

Molten metal flows evenly into all parts of the mold, then solidifies into pre-shaped parts with uniformly dependable properties throughout. Malleable iron castings will stand up under extremes of tension, impact, torsion, shear, fatigue, wear, heat, cold, and corrosion. They also offer maximum economy, are easy to work, and are versatile enough for parts ranging from a few ounces to hundreds of pounds.

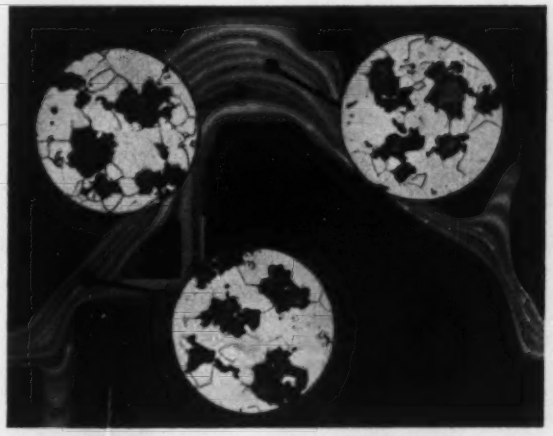
The more manufacturers know about Malleable castings, the more they use Malleable to improve quality and increase profits. Get the full story on Malleable ... Contact any of the progressive companies that display this symbol —

MEMBER
MALLEABLE
CASTINGS COUNCIL

For details on Malleable's uniformity and reliability contact any company listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

Malleable Castings...
Uniformly Dependable All The Way Through!

Section a Malleable iron casting . . . check it under the microscope. You will find it shows a similar microstructure all the way through . . . and, therefore, gives you unvarying strength, toughness, and easy machinability.



Structural uniformity in a typical Malleable casting is seen in these micrographs from thick and thin, center and near-surface areas of the automotive differential carrier shown in the color illustration. Samples are magnified 100 times after 3% nital etch.

Uniformity Assures Design Versatility and Easy Machinability

Malleable's structural uniformity and unvarying strength permit designs of any practical configuration based on the functional requirements of the part. The malleablizing process relieves internal stresses, and assures fast, problem-free machining.

The Proof Is In The Using

The ultimate proof of a material's quality comes from actual use by customers. Truck and car torsion arms absorbing millions of road shocks, vital tractor parts performing equally well in the Sahara and the Antarctic, and thousands of other applications provide continuous proof of Malleable's unexcelled uniformity and reliability.

Free Assistance and Information

Any member of the Malleable Castings Council will be pleased to assist you in making engineering decisions for effective use of Malleable castings. For further information, call or write today to any of the companies listed below for *Data Unit No. 103 "Uniformity"*, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

For Quality and Economy...Use MALLEABLE

For Service In Your Area Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

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SQUIRREL-CAGE GRIDS FOR HIGH-FREQUENCY ELECTRON TUBES
For high-frequency vacuum-tube grids manufactured by General Electric Company, only a Platinum-clad wire, such as produced by Engelhard Industries, was able to provide the properties to assure efficient grid and tube operation.

Where no metal but Platinum will do the job as well...

This cage is used by General Electric Company to tame electrons in a vacuum tube. It's called a squirrel-cage grid, and is used to control the electrons flowing from the hot cathode to the plate, or anode.

Some grids become contaminated by material from the hot cathode and then may *emit* electrons, which upset normal behavior of the tube and may even cause its destruction. This occurs when the work function of the grid becomes too low—when it is too easy to boil off electrons.

Platinum has a very high work function (over six electron volts) and, more important, it remains reluctant to emit electrons even after contamination from the nearby hot cathode.

This is why vacuum tube designers at General Electric's Power Tube Department in Schenectady specified platinum-clad wire for both the control and screen grids in two highly sensitive electron tubes . . . the G1-6251 and the G1-6942 . . . ceramic tetrodes for VHF television and UHF bands. The electronic properties of platinum, with the high temperature strength of tungsten, are combined in platinum-clad tungsten wire as the answer to the problem.

With its high melting point and its unique ability to absorb contaminating thorium, without significant impairment of its high work function—no metal but platinum is able to do this job as well!

PROPERTIES THAT SOLVE PROBLEMS

Where conditions involve low vapor pressure and high work function—as in the operation of high-frequency electron tubes; or where high-temperature stability is a must—as in the production of glass fiber; or where wear-resisting, highly conductive surfaces are needed—as in the production of printed circuits; or where peak catalytic efficiency is called for—as in the refining of high octane gasoline...the platinum metals often prove to be the *only* solution to the problem, as well as the most economical materials to use.

Perhaps your own progress has been blocked by the limitations of materials to withstand such severe conditions. If so, platinum, palladium, rhodium, ruthenium and iridium—each possessing a unique combination of properties—are well worth your attention and consideration.

Specialists are prepared to work with you in evaluating these metals for new commercial and scientific uses. As a first step, write us for additional data on the outstanding characteristics and successful applications of the six platinum metals and their alloys—indicating your field of interest or how we might be of assistance.

CAN THESE PROPERTIES OF THE PLATINUM METALS HELP YOU?
Low Vapor Pressure
High Temperature Stability
Superior Wear Resistance
Peak Catalytic Activity
Exceptional Chemical Inertness

The six platinum metals are:
PLATINUM • PALLADIUM • RHODIUM • RUTHENIUM • IRIDIUM • OSMIUM

INCO TRADE MARK PLATINUM METALS DIVISION
The International Nickel Company, Inc., 67 Wall Street, New York 5, N.Y.

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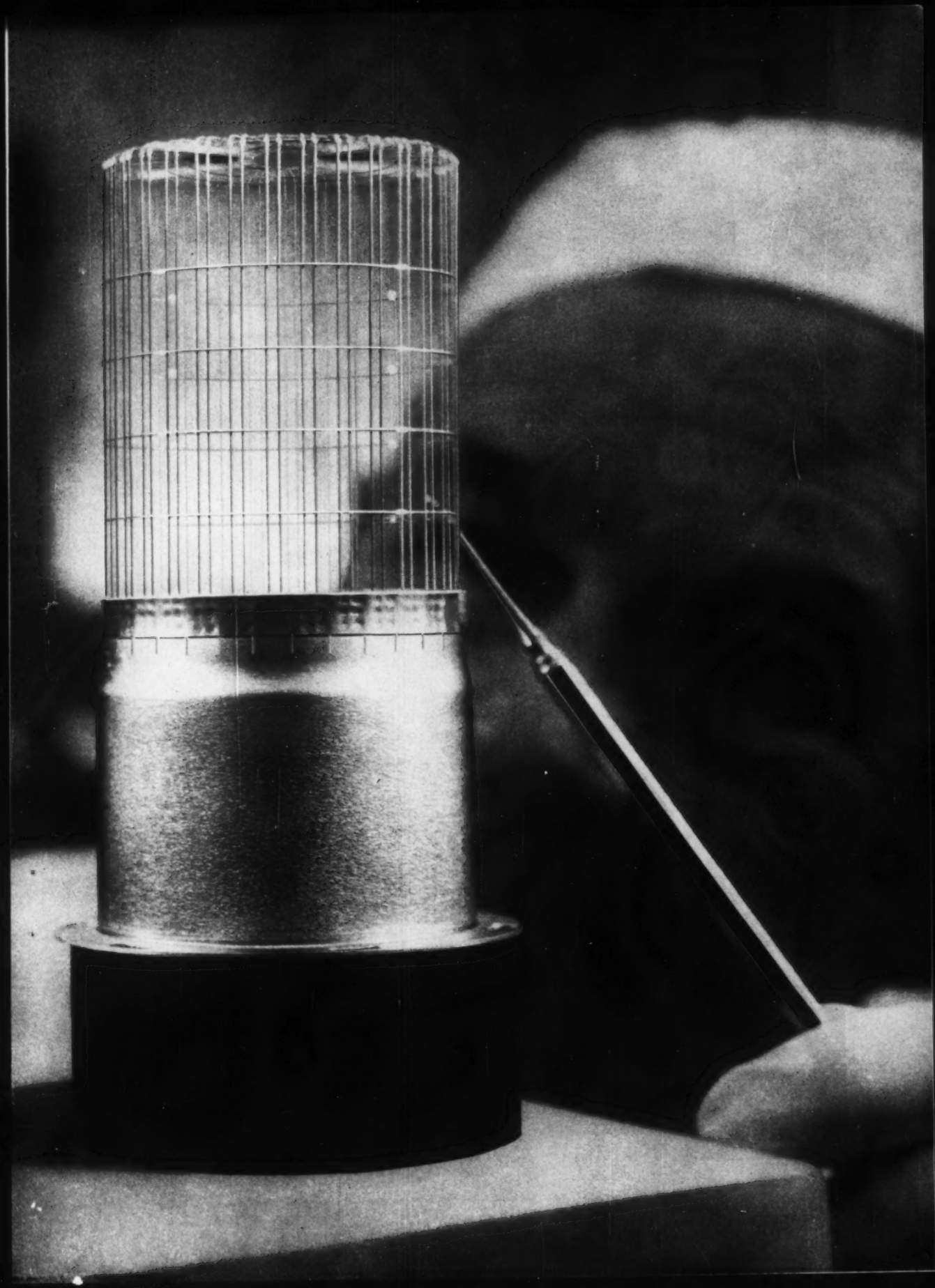

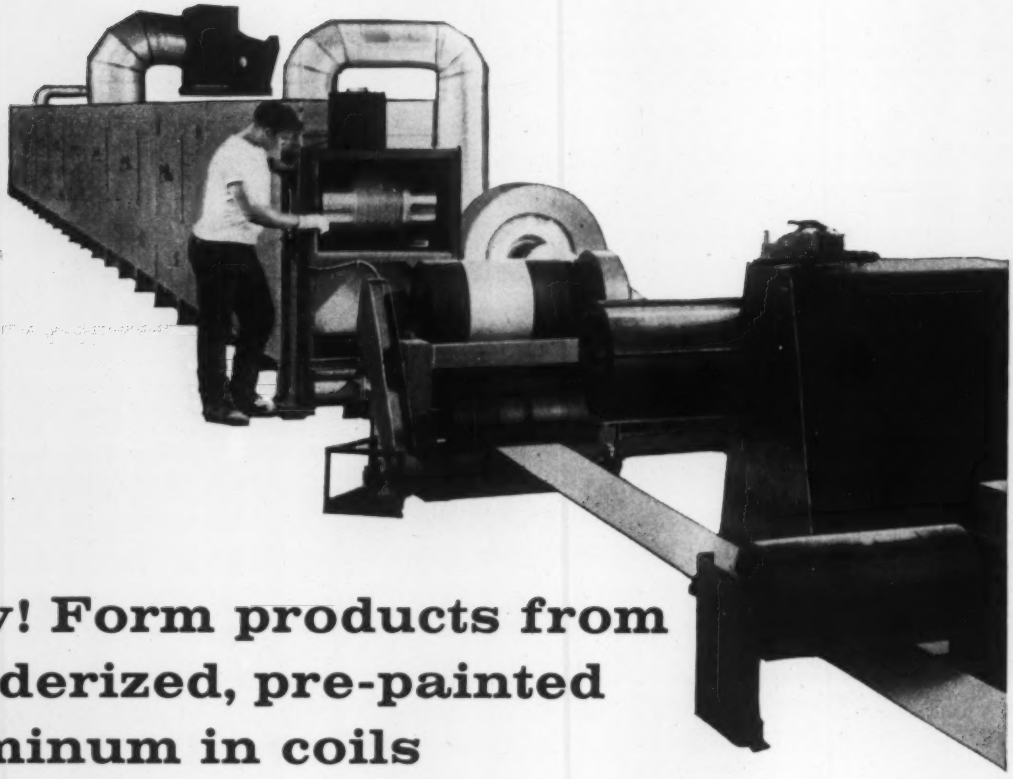

Now! Form products from Bonderized, pre-painted aluminum in coils

A modern, new way to better products at lower manufacturing cost. Use Bonderized aluminum coil stock with baked-on paint, ready for fabricating.

Automated straight-line production assures uniform Bonderized and roll coat painted coil meeting the highest quality control standards.

The Bonderite coating on aluminum stock accomplishes the double job of controlling corrosion and anchoring the paint. Paint adhesion is so spectacular that the most severe forming operations can be accomplished without finish failure.

Service life of paint over Bonderized aluminum is five to ten times that on untreated aluminum!

Improve manufacturing efficiency, product performance and customer satisfaction by forming your aluminum products from Bonderized, pre-painted coil stock. The Parker representative has complete, helpful information for you.

Since 1914— leader in the field

Parker Rust Proof

2173 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE corrosion resistant paint base	BONDERITE and BONDERLUBE aids in cold forming of metals	PARCO COMPOUND rust resistant	PARCO LUBRITE—wear resistant for friction surface

**Bonderite, Bonderized, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

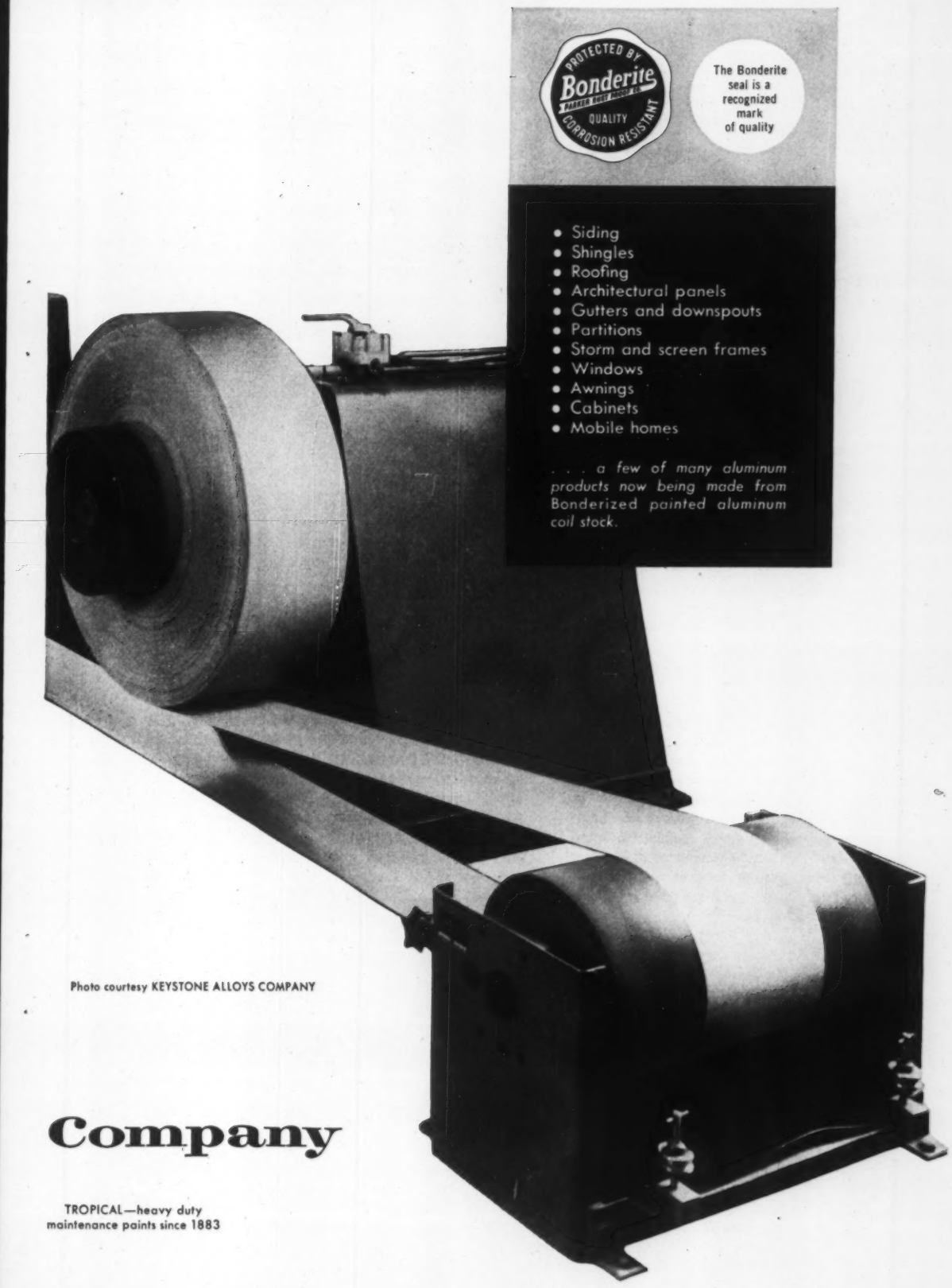

Photo courtesy KEYSTONE ALLOYS COMPANY

Company

TROPICAL—heavy duty maintenance paints since 1883

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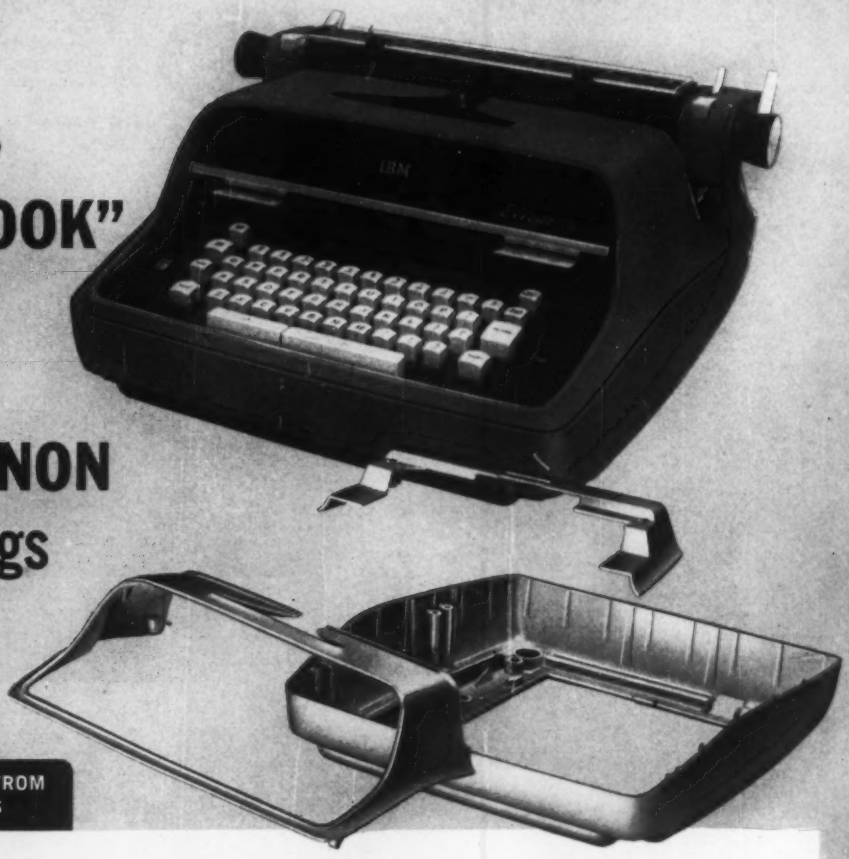
IBM's "NEW LOOK" enhanced with MT. VERNON Die Castings



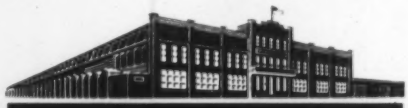
CASE HISTORIES FROM MT. VERNON FILES

Behind the sleek silhouette of the dramatically new IBM electric typewriters is "more than a quarter of a century of experience . . . a combination of styling and engineering advances" that promise — and deliver — better performance and easier typing.

For its enclosure IBM knew what it wanted: a new high in eye-pleasing design combined with the many low cost, production benefits of die-casting. It was only natural that, for these die castings, once again, they turned to Mt. Vernon, a reliable supplier to IBM for over 25 years.

And, once again, they found Mt. Vernon's co-ordinated four-fold service — designing, die making, casting, and machining—equal to the job of meeting their strict requirements: strong, gracefully arched, thin-walled, large aluminum sections that match and fit perfectly. The three castings that cradle and enclose the intricate typewriter mechanism are delivered completely machined, ready for finishing.

Like IBM, leading manufacturers in all industries know and rely on Mt. Vernon's experienced use of its complete facilities for die cast zinc and aluminum parts ready for assembly. These services, all under one roof in 200,000 square feet of space, may hold the answer to your design and production problems. Think about it . . . and let us know. We'll gladly talk it over, without obligation. Just call your nearest Mt. Vernon sales representative.



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CLEVELAND, OHIO: Mr. Grant Eller, 6 East 194th St.
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LUTHERVILLE, MD.: Mr. C. McIntosh Gordon, Box 55, R.R. No. 1
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STAMFORD, CONN.: Mr. Anker Anderson, Cascade Road
VALLEY FORGE, PA.: Mr. G. T. McMaster, P.O. Box 115

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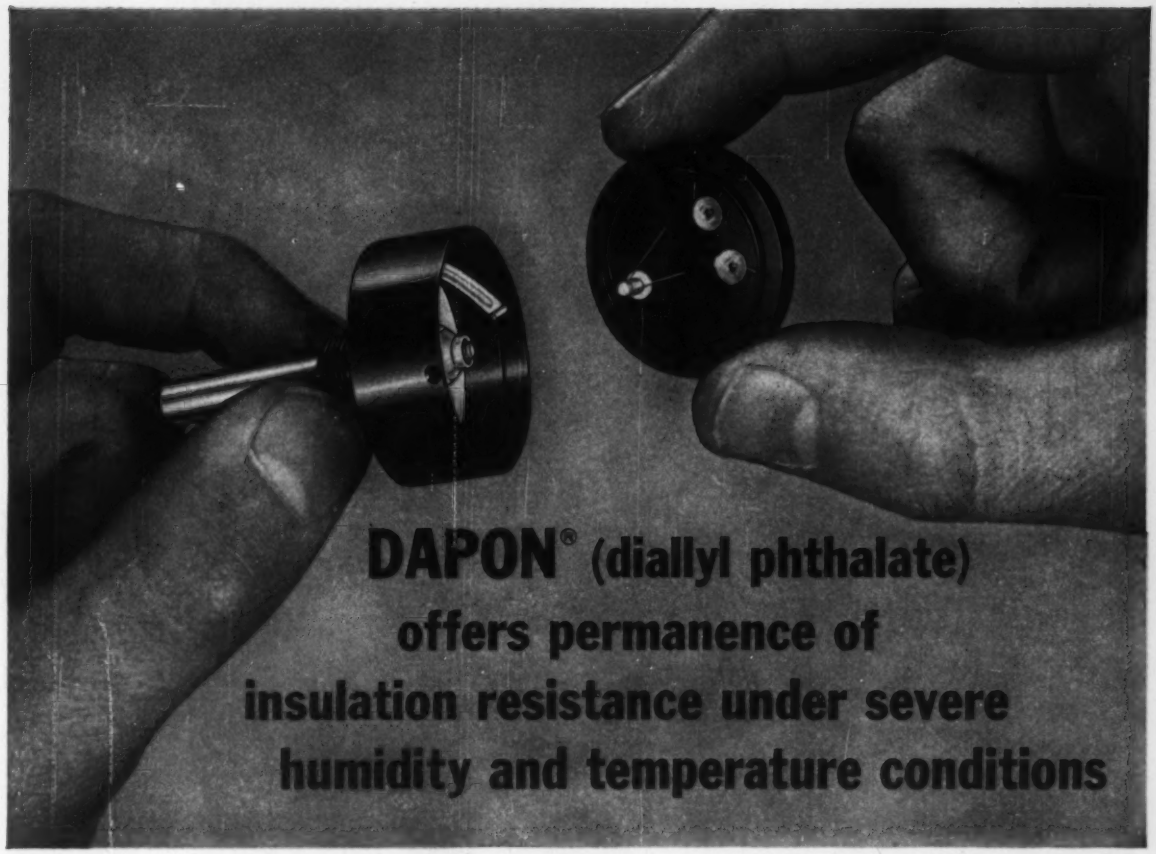


DAPON® (diallyl phthalate) offers permanence of insulation resistance under severe humidity and temperature conditions

This plastic is ideal for applications where changes in humidity can affect electrical values. DAPON can prevent costly "in service" failures in electrical and electronic components.

A new molded plastic potentiometer produced by New England Instrument Company features exceptional resistance to humidity, high reliability and low noise. A raised conductive plastic ring is used in place of resistance wire in these miniature units. The new potentiometers are ideal for servo and instrumentation applications where long life and extreme accuracy are important factors.

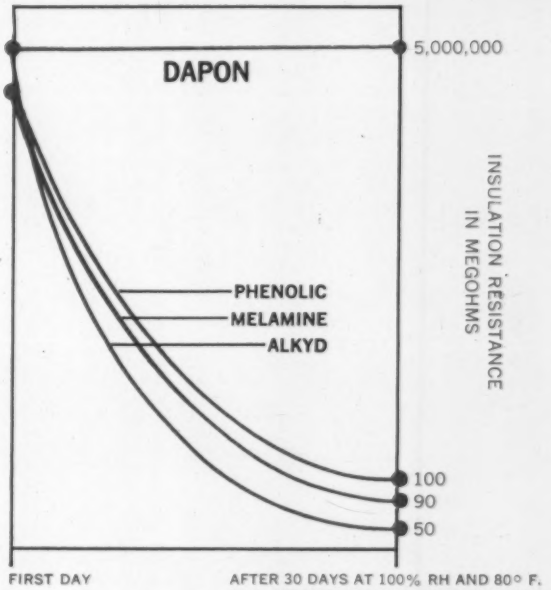
The solid resistance element, insulating base and silver terminal leads are molded in one operation with DAPON (diallyl phthalate) Resin. Result: a single, almost indestructible precision unit.

New England Instrument chose DAPON because of its superior electrical and physical properties, and its low moisture absorption. DAPON also molds easily around metal inserts without cracking, and withstands extremes of temperature, vibration and shock.

Specify DAPON (diallyl phthalate) Resin when you need:

- Low dielectric loss
- High dielectric strength
- Superior dimensional stability
- Excellent arc resistance
- High volume and surface resistance after high humidity-high temperature conditioning

Write for FMC's data sheet containing technical information about DAPON, suggested uses for this resin, and the names of DAPON compounders.



FOOD MACHINERY AND CHEMICAL CORPORATION
Dapon Department
161 East 42nd Street, New York 17, New York

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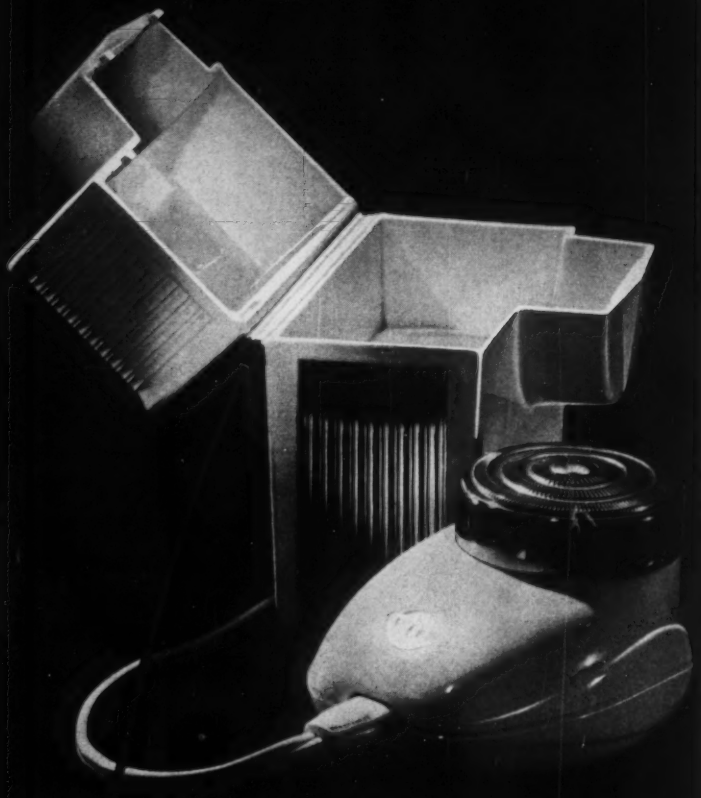
there are always good reasons for designing it in

polypropylene



The new Wen Shaver Kit is molded in one piece . . . including self-hinge, which was flex-tested by Wen *a million times*. Tough Polypropylene is the only material you can use for cost-saving designs like this. Custom-molded by Industrial Molded Products Co., Inc., Palatine, Ill.

in Wen Shaver Kits *it's economy*

Wen's requirement: an attractive, shatterproof shaver kit at lowest possible cost. The answer, after extensive testing: AviSun Polypropylene. Molds beautifully, with high gloss. No "soapy" feel, no dust problems. The only practical material for a self-hinge. Makes possible single cavity molding, cuts production time 60%, saves 15c hinge cost per kit. Highly heat resistant, won't warp.

Polypropylene makes better products at lower cost. No other material has this combination of properties:

1. **Heat Resistance**
2. **Chemical Resistance**
3. **Toughness**
4. **Economy**

AviSun's technical specialists will be glad to work with you on your specific applications. Write for Booklet AP-601 giving complete technical information.

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A new family of materials to meet special problems

•

SHOCK
STRESS
ABRASION

AMSCO® ALLOYS

In addition to austenitic manganese steel castings—long known for their exceptional service life in mining, construction, quarrying and milling applications—Amsco now offers *seven* other ferrous alloy materials. These include specially alloyed manganese steels, chrome moly steels, high strength alloyed steels and alloyed cast irons.

Each has particular advantages for specific service requirements, involving various combinations of impact, stress and wear. Check the brief facts on these alloys below. Then call in an Amsco sales engineer to assist in selecting the *one best* material to meet your application needs.

AMSCO ALLOY DESIGNATION	DESCRIPTION AND USES	MECHANICAL PROPERTIES
MY	Heat-treated, chromium alloyed manganese steel... for use in light-to-medium weight castings requiring modest improvement in growth and distortion, and increased stiffness.	tensile strength ..... 120,000 psi yield strength ..... 56,000 psi elongation ..... 45% reduction of area 30%
MML	Heat-treated, molybdenum alloyed manganese steel... for castings requiring improved weldability, for extremely heavy metal sections, and castings exposed to excessive heating environments.	tensile strength ..... 120,000 psi yield strength ..... 52,000 psi elongation ..... 50% reduction of area 40%
MMH	Heat-treated, molybdenum alloyed manganese steel... for use in castings requiring optimum mechanical properties and wear resistance. Provides improved stiffness and resistance to peening and flow.	tensile strength ..... 120,000 psi yield strength ..... 65,000 psi elongation ..... 20% reduction of area 18%
CML	Heat-treated, air-hardening chrome-moly steel... for casting applications involving scouring or grinding wear. Suitable for more complex casting designs.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 10% reduction of area ..... 15% hardness ..... 275-375 BHN
CMH	Heat-treated, air-hardening chrome-moly steel... exhibits potentially improved wear resistance over CML (above), when shock loading is not sufficiently severe to cause breakage.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 6% reduction of area ..... 7% hardness ..... 300-400 BHN
CS	Martensitic, multiple alloy steel with chromium, nickel and molybdenum... combines high mechanical strength with good abrasion and wear resistance.	tensile strength ..... 220,000 psi yield strength ..... 195,000 psi elongation ..... 8% reduction of area ..... 20% hardness ..... 300-500 BHN
HC	High chromium cast iron... provides outstanding abrasive wear resistance, where impact force is low but particle velocity and scouring forces are high.	tensile strength ..... 60,000 psi transverse strength ..... 7,000 lbs. deflection ..... 0.12 in. hardness ..... 400-600 BHN

For further information
—write for technical bulletin on "Amsco Ferrous Alloy Castings".

AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division • Chicago Heights, Illinois

For more information, turn to Reader Service card, circle No. 325

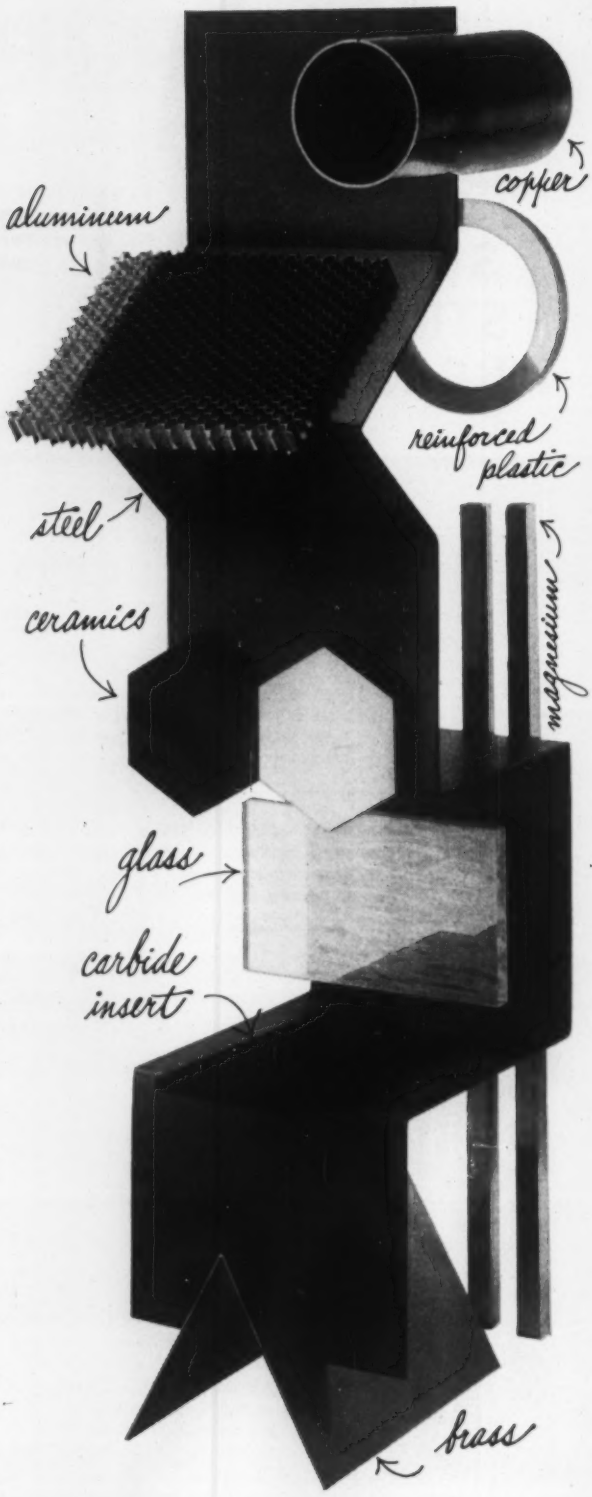
WHAT DO YOU WANT TO BOND TO WHAT?

Take a structural material—for instance, any of the materials shown to the right. Want to join it to itself or another material? Then chances are that SCOTCH-WELD® Brand Structural Adhesives are your best fabricating answer. This modern high strength method of joining materials permits improved design and production techniques . . . cuts costs . . . offers unique benefits.

For example: Smoother contours result when mechanical fasteners are eliminated. Fabricating complex shapes—often impossible or too expensive with ordinary fastenings—is made easy and economical with SCOTCH-WELD Adhesives. In fact, costly complex castings can often be replaced by two or more inexpensive simple castings bonded together with SCOTCH-WELD Adhesives. And lighter gage materials may be used where desired, since stress is spread over a wide area. Often, too, inspection and production steps can be eliminated. Another benefit—unusual combinations of materials which can be joined in no other way can be bonded perfectly with SCOTCH-WELD Adhesives.

Throughout the metalworking industry, bonding with SCOTCH-WELD Brand Structural Adhesives is improving quality, speeding production and cutting costs.

SCOTCH-WELD Adhesives may be the answer to your design and production problems . . . and improve your product at the same time. For full information write on your company letterhead, outlining area of interest, to: AC&S Division, 3M Company, Dept. SBHH-120, St. Paul 6, Minn. "SCOTCH-WELD" is a Reg. T.M. of 3M Co.



ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

For more information, turn to Reader Service card, circle No. 395

Photo and unretouched x-ray show automatic pilot grip for B-58 Hustler bomber. Plastics fabrication by Swedlow Control stick assembly by H. W. Loud Machine Works, Inc. B-58 by Convair, a Division of General Dynamics Corporation.

PILOT'S GRIP BY SWEDLOW: A STUDY OF ADVANCES IN REINFORCED PLASTICS

This pilot's hand grip must withstand 500 lbs. fore and aft pressure; 200 lbs. lateral pressure, yet be light in weight. It must contain a handful of electrical controls; over a score of connections—so it must have dependable electrical properties. Quite a problem. The Swedlow answer: an epoxy resin system and two forms of glass fabric... plus an ingenious multi-step molding and curing process to get the most from the materials. Result: a handle which meets specifications, needs only one-shot machining. The techniques and proprietary processes developed to solve this problem represent the most advanced skills and insight necessary for plastics fabrication today and tomorrow.

Put these Swedlow skills to work on your problem. Write for full information, to Dept. 18.

For more information, circle No. 435

SWEDLOW Inc. LOS ANGELES 22, CALIFORNIA · YOUNGSTOWN 9, OHIO

Swedlow

WELDING HELMETS SERVING TRAYS MODERN CHAIRS MERRY-GO-ROUND HORSES

So many good things serve you better because of fiber glass

(Johns-Manville Fiber Glass, that is!)

Sturdy, weather-resistant playtime equipment . . . rust-proof gardening gadgets . . . all kinds of protective headgear. There are thousands of intriguing, lightweight plastic products that serve you better and last longer because they are reinforced with Johns-Manville fiber glass. It has opened new worlds of useful products that are both easy to maintain and pleasing in design.

BOWS & ARROWS FIRE HELMETS GARDEN HOSE REELS HAMMER HANDLES TOTE BOXES

The tough glass fibers produced by Johns-Manville for the reinforced plastics industry (available as fabric, roving, and mat) are stronger than steel by weight . . . lend strength and exceptional durability when combined with plastics.

Perhaps you can improve your product—or develop new ones—with Johns-Manville fiber glass textile products. For information, write: Johns-Manville, Box 14, N. Y. 16, N. Y. In Canada: Port Credit, Ont. Cable address: Johnmanvil.

J-M GARAN® FIBER GLASS ROVING

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE
FIBER GLASS

For more information, turn to Reader Service card, circle No. 459

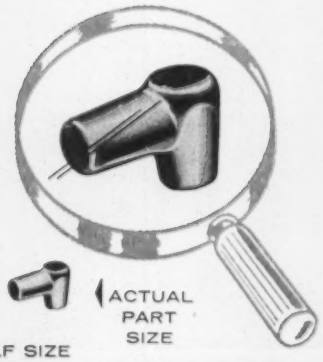
MUELLER BRASS CO. PRODUCES

SPECIFICATIONS . . . *REGARDLESS OF*

To obtain the desired physical and design requirements in a part at the lowest cost, there is usually one specific process by which that part can be most successfully and economically manufactured. Because the Mueller Brass Co. offers a variety of production methods, you get sound engineering, accurate production method analysis, our assurance of getting the best product at the lowest cost . . . regardless of metal specified or the size of your particular part.

BRASS, BRONZE, ALUMINUM FORGINGS

The two parts shown here dramatically illustrate the ability of the Mueller Brass Co. to produce precision forgings regardless of size or configuration. Both the tiny dental drill nozzle and the big heat exchanger shell hub, which is the largest of its kind ever produced, were forged to exacting specifications. The weight of the nozzle is only a few ounces while the shell hub weighs 40 lbs., and has a forged pocket 7 1⅛" in diameter and 4⅜" deep. By way of size comparison, the pocket is big enough to hold over 14,000 of these tiny drill nozzles. By forging the pocket, considerable machining time and money was saved. The sound, dense structure of the shell hub makes it ideal for the high pressure application for which it was designed. The forging not only does the job better, but was produced for 25% less than the casting it replaced. Experience makes it possible for the Mueller Brass Co. to produce high quality precision forgings regardless of specifications . . . why not put this experience to work for you?



ONE DEPENDABLE

Write today for Engineering Bulletins on any of these Products.

SCREW MACHINE PRODUCTS

POWDERED METAL PARTS

MUELLER BRASS CO.

MUELLER BRASS CO.

PARTS ECONOMICALLY...TO EXACT

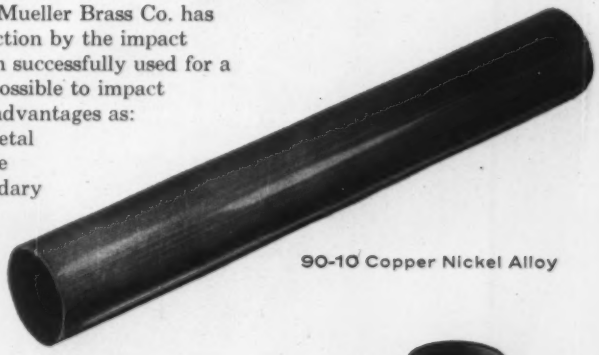
METAL, METHOD OR SIZE...

When you are designing, specifying or purchasing fabricated parts, call in the "Man From Mueller Brass Co." to help lower costs and improve your products. Sales and engineering service is available to you at Mueller Brass Co. offices throughout the United States. Make Mueller Brass Co. your one dependable source for all your part needs.

COLD PREST® IMPACT EXTRUSIONS

Today, because of vast experience in alloys, the Mueller Brass Co. has greatly expanded the possibilities of parts production by the impact extrusion method. Aluminum, of course, has been successfully used for a multitude of tubular shapes. But now it is also possible to impact parts of copper alloys incorporating such major advantages as: closer tolerances, better finish and appreciable metal savings. Because of dimensional accuracy possible with the impact extrusion, the necessity of secondary machining operations is often eliminated.

The parts shown here are representative of the group now being economically produced as impact extrusions by the Mueller Brass Co. who offer complete engineering and design service in the development of new parts from copper base alloys.



90-10 Copper Nickel Alloy

Aluminum Alloy 6061

Oxygen Free High Conductivity Copper

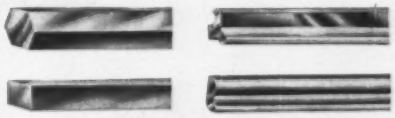
Special Alloy 902

Tellurium Copper Alloy

Low Phosphorus Copper Alloy

SOURCE FOR ALL THESE OTHER PRODUCTS

FORMED COPPER TUBE



STANDARD and SPECIAL ALLOY ROD

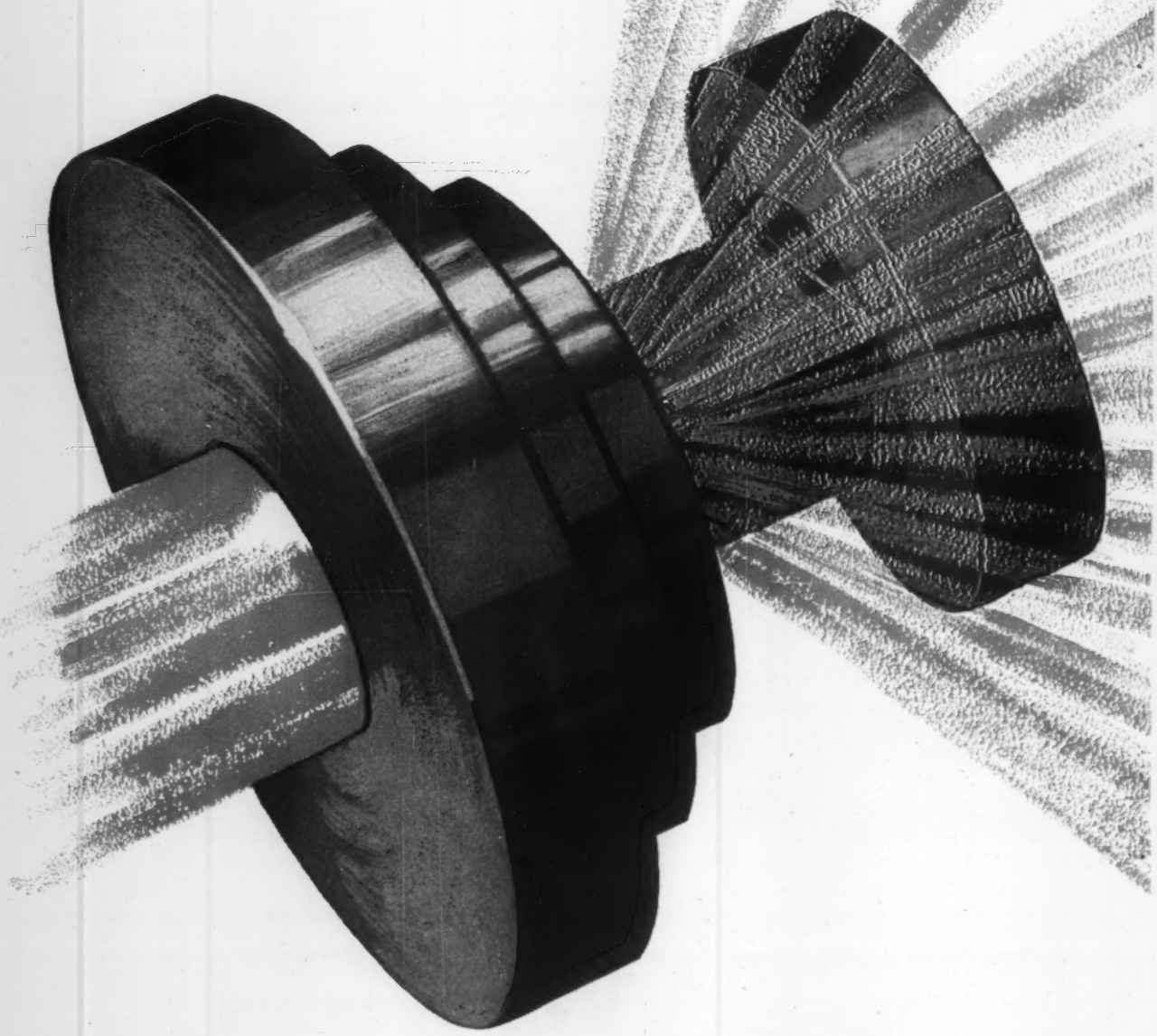
PORT HURON 21, MICHIGAN

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

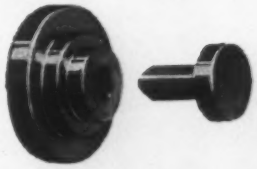
319

For more information, turn to Reader Service card, circle No. 399

FOR THE MACHINERY PART



THAT TAKES THE BEATING



Liquids forced at high pressure through restricting valves—of HAYNES STELLITE alloy! That's the modern way by which hundreds of products are homogenized today, to make better dairy, chemical, food, and textile products, to name a few.

HAYNES alloys have been a standard material for homogenizer valves for 25 years. Valves that remain free from roughness, porosity, sharp corners, pits. Valves that retain their dimensions where pressures may reach 15,000 psi, and liquid velocities exceed 30,000 ft. per minute. Valves that keep products clean and free from contamination and give long service despite corrosive and abrasive conditions.

If design and production in your field call for tough metal parts, look into HAYNES alloys. There are more than 15 to choose from including HAYNES STELLITE cobalt-base alloys, HAYNES iron-base alloys, HAYSTELLITE cast tungsten carbide, and HASTELLOY nickel-base alloys. They are available as castings, forgings, completely fabricated parts, or as sheet and bar stock. All parts can be furnished machined or ground to specified size and finish.

Our engineers will help you pick the right HAYNES alloy to resist practically any condition of wear, heat, or corrosion. For more information write for descriptive literature.

HAYNES Alloys *will do the job!*

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of
Union Carbide Corporation
Kokomo, Indiana

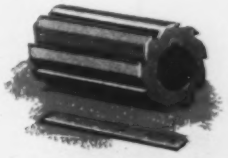
UNION CARBIDE

The terms "Haynes," "Haynes Stellite," "Hastelloy," "Haystellite," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

TYPICAL "HAYNES" ALLOY MACHINERY PARTS

Chuck inserts of HAYNES STELLITE alloy last up to 50 days—2 shifts daily—holding heavy pieces during a cut-off operation.

Seam rollers on milk-can machines turn out 2 to 3 times as many cans now that the rollers are made of HAYNES STELLITE alloy.



Cutters and bed knives made of HAYNES STELLITE alloy stay clean and sharp for years while pelletizing extruded polystyrene.

For more information, turn to Reader Service card, circle No. 377

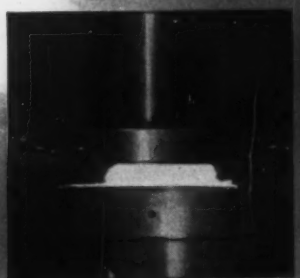
BENDIX CHROME CERAMETALIX®

New Bendix high-temperature material resists oxidation, acids, caustics...retains strength at 3000°F.

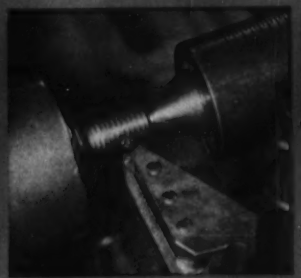
Chrome Cerametalix is the latest product of the Bendix Cerametalix laboratories. A unique chromium based cermet (ceramic-metallic material), it is ideally suited for applications in corrosive or oxidizing atmospheres in the 2000° to 3000°F. range. It combines resistance to heat, oxidation, and erosion with strength and hardness. Chrome Cerametalix offers great promise in aircraft, missile, and gas turbine engine components, and in a wide range of industrial processes including the steel and petroleum processing industries. In addition, the ability to machine and work Chrome Cerametalix with conventional methods and equipment makes it especially attractive to designers.

For complete information on this remarkable new material, write Cerametalix Sales Department.

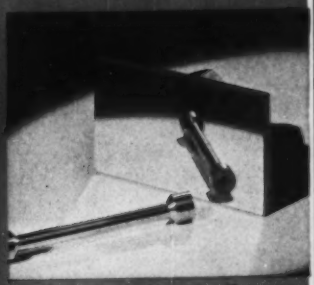
Bendix PRODUCTS DIVISION South Bend, IND.



FORGEABLE, WORKABLE—Chrome Cerametalix can be forged and hot worked.



MACHINEABLE—This material can be precisely machined using conventional methods and equipment.



MICRO-SURFACE FINISH—Chrome Cerametalix can be polished to a micro-surface finish with standard machines.

For more information, turn to Reader Service card, circle No. 333

AGAIN-

Revere helps "fit the metal to the job"

AND A COMMUTATOR MANUFACTURER SAVES ON BOTH MATERIAL COSTS AND OVERALL COSTS WHILE PRODUCING A SUPERIOR PRODUCT

The hub of the small commutator you see above originally was made of a ferrous metal. Certain problems cropped up due to the fact that the rod from which the hubs were fabricated, not only had to be drilled, but it also had to be able to withstand a flanging operation. The engineering department of Dayton Precision Manufacturing Company called in one of Revere's Technical Advisors for consultation.

After a thorough study of the problem Revere Brass Rod of a certain alloy was recommended and samples were furnished. The machinability of the rod was found to be outstanding, being readily and speedily drilled. Also it withstood the flanging operation . . . a set of manufacturing conditions where only brass, the right kind of brass, outshines all other metals and alloys.

Final score: The low first cost of the brass rod, plus its superior machinability, resulted in a more satisfactory product without the penalty of higher costs. A further advantage to the manufacturer was the added sales appeal of the brass hub.

And there you have another example of how Revere in collaboration with the manufacturer helped, "fit the metal to the job," which resulted in a better part at the least possible cost. Why don't you take advantage of this kind of service?

REVERE

COPPER AND BRASS INCORPORATED

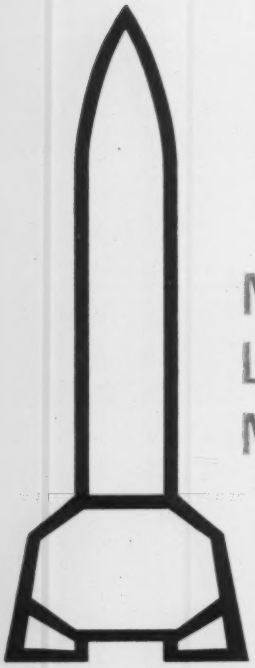
Founded by Paul Revere in 1801

230 Park Ave., New York 17, N. Y.

Sales Offices in Principal Cities. Mills: Rome, N. Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford and Plymouth, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb.

Distributors Everywhere.

For more information, turn to Reader Service card, circle No. 453



MISSILE LAUNCHER MADE MOBILE-LIGHT, TAKEOFF-TOUGH WITH

N-A-XTRA

HIGH-STRENGTH STEEL

A battlefield might be anywhere. Wherever it is, there may be a need for the new 10,000-pound, 36-foot Sperry-Rand U.S. Army Sergeant missile. That's why the launching station on which the missile is assembled, aimed and fired must be light enough to be transported by land, sea or air. Yet it also has to be rugged and strong enough to assure the launcher's availability for subsequent firing.

N-A-XTRA steels meet all the conditions of light weight, high strength and impact resistance. Pound for pound, they're nearly three times stronger than mild carbon steel. They are used, not only in this mobile missile launcher, but in many other defense products and in commercial equipment such as earth-moving vehicles, heavy machinery and pressure vessels.

Fabrication qualities are an N-A-XTRA bonus. Even at extreme subnormal temperatures, they remain tough and readily weldable. Conventional methods—cold forming, gas cutting, shearing and machining—give superior results, too. For further information, write Product Development Department, Great Lakes Steel Corporation, Detroit 29, Michigan.

N-A-XTRA

A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan

Quenched and tempered N-A-XTRA, *the best low carbon extra-strength alloy steels you can buy, are available in four levels of minimum yield strength, from 80,000 to 110,000 psi. They are tough at normal and subnormal temperatures and can be readily and reliably welded. Sizes range from ⅛" to 1" thick, up to 72" wide and up to 35' long.*

Steel

Look for the STEELMARK on the products you buy; place it on the products you sell.

***Great Lakes Steel is a Division of* NATIONAL STEEL CORPORATION**

For more information, turn to Reader Service card, circle No. 370

"Not one failure in 10 years with USS American springs"

Mr. Lee Dunn, Sales Manager of Walter Balfour & Co., Inc., tells why American Steel & Wire Springs are used in Balfour Doc-Port Rolling Steel Pier doors.

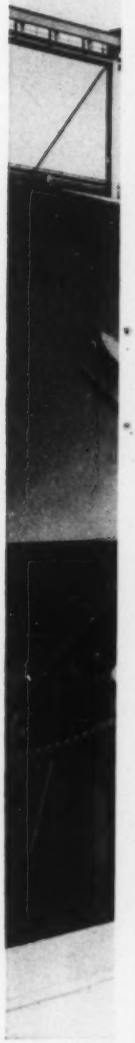
"The springs in our doors have to be exceptionally tough and dependable," says Mr. Dunn. "The performance of the doors is dependent upon the quality of the springs. The springs must act uniformly over their entire length because the doors must be perfectly counter-balanced at every point of travel. Springs of the same wire diameter and coil diameter *must* have identical characteristics. In the ten years we've been using American Steel & Wire springs, we've never experienced a failure.

"Most of the USS American springs used by the Balfour Company are made from 7/16" cold wound wire. In the larger steel pier doors there are actually multiples of our helical torsion spring sizes . . . 5/8", 9/16", 1/2", and 13/32". Springs are nested one within another, each spring mounted on shaped cast anchors which are fixed to a single torsion rod, so that the springs are equally and simultaneously loaded."

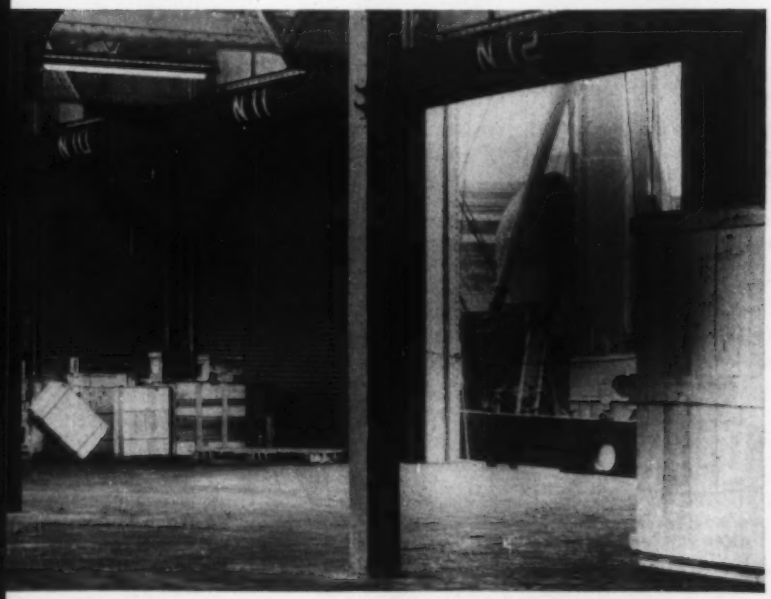
When springs are your special problem, come to American Steel & Wire. Our Spring Engineering Service has a solid reputation for coming up with the right answer at the right time. They'll be glad to pitch in on your problem. Give us a call today, or write American Steel & Wire, Dept. 0409, 614 Superior Avenue, N.W., Cleveland 13, Ohio.

USS and American are registered trademarks

Cold wound springs in Balfour doors are placed inside steel cylinders and fixed on each end to anchors that prevent internal collapsing of the springs at contact points.



Balfour doors are exposed to heavy wind loads and salt water spray, but they can take it—and so can the USS American springs.



3000 lbs. ride on each USS American spring assembly every time these big 18' x 24' Balfour Pier doors open and close. It takes rugged, long-lasting springs to stand up under this kind of punishment.

American Steel & Wire
Division of
United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
Tennessee Coal & Iron Division, Fairfield, Alabama, Southern Distributors
United States Steel Export Company, Distributors Abroad

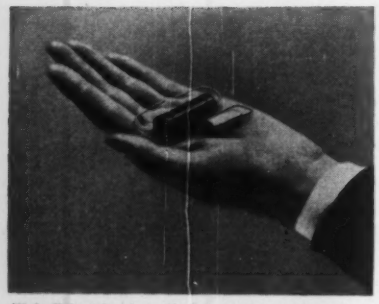
This mark tells you a product is made of modern, dependable Steel.

For more information, turn to Reader Service card, circle No. 328

This is an actual photograph of "Mylar" undergoing dielectric strength test (per ASTM-D-149).

MYLAR® has a dielectric strength of 4,000 volts per mil

Can the unique combination of properties found in "Mylar" help you solve your design problems?



High dielectric strength helps cut capacitor size. Tough, thin "Mylar" with a dielectric strength of 4,000 volts per mil for 1 mil film (per ASTM-D-149) permits capacitor manufacturers to reduce size of finished unit . . . improve performance and reliability.

"Mylar"* polyester film is a tough, flexible engineering material. In addition to its outstanding dielectric strength, "Mylar" has an average tensile strength of 20,000 psi, withstands temperature extremes (-60° to 150° C.) . . . resists most chemicals and moisture.

On an area basis, tough, thin "Mylar" often *costs less* than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't embrittle with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the *combination of properties* in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write for our booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room M-12, Wilmington 98, Del.

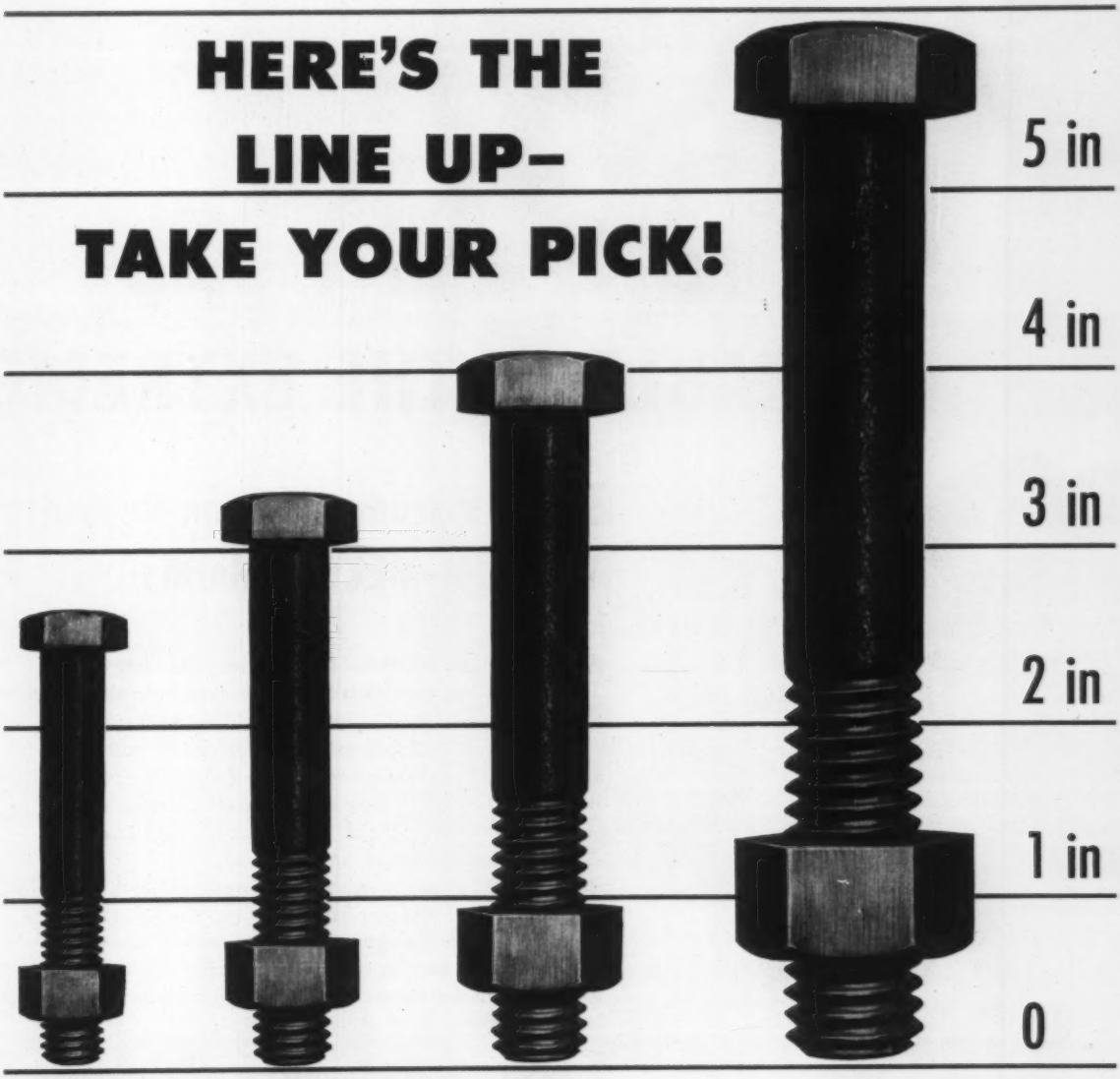
*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT MYLAR® POLYESTER FILM

For more information, turn to Reader Service card, circle No. 352

HERE'S THE LINE UP— TAKE YOUR PICK!



In the market for machine bolts?
We make a full line of sizes.
Carriage, and lag bolts also.
And they're all top quality.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Sales Bethlehem Steel Export Corporation.

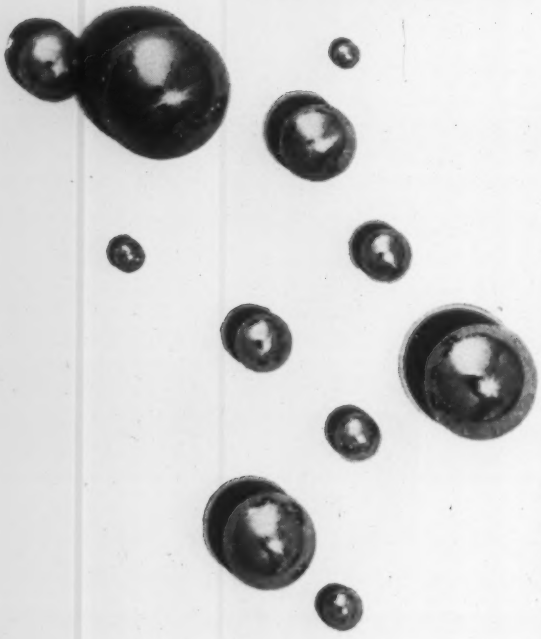
BETHLEHEM STEEL

Steel

for strength
. . . economy
. . . versatility

For more information, turn to Reader Service card, circle No. 335

DURABLE IN THE EXTREME



...parts produced from Republic VACUUM-MELTED Metals

A leading manufacturer of ball bearings uses Republic Type 52100 Vacuum-Melted Alloy Steel in bearings produced for aircraft and missile applications. This steel provides excellent resistance to erosion, corrosion, abrasion, and impact. The alloy is supplied to the manufacturer in bars. It is then drawn into wire rods, annealed, drawn to size, sheared into slugs, forged, heat treated, rough ground, tempered, finish ground, and polished.

Produced by the consumable electrode process, Republic Vacuum-Melted Metals offer higher mechanical properties—ductility, tensile strength, and longer fatigue life—with nonmetallic inclusions reduced in number and size. Republic can deliver these metals in quantity on time, and in a wider range of sizes and conditions than ever before possible.

Our metallurgists will quickly help you select, apply, and process vacuum-melted metals: *super alloy steels, constructional alloy steels, high strength alloy steels, bearing steels, stainless steels, titanium,* and *special carbon steels.* For complete information, contact your nearest Republic sales office or return the coupon.

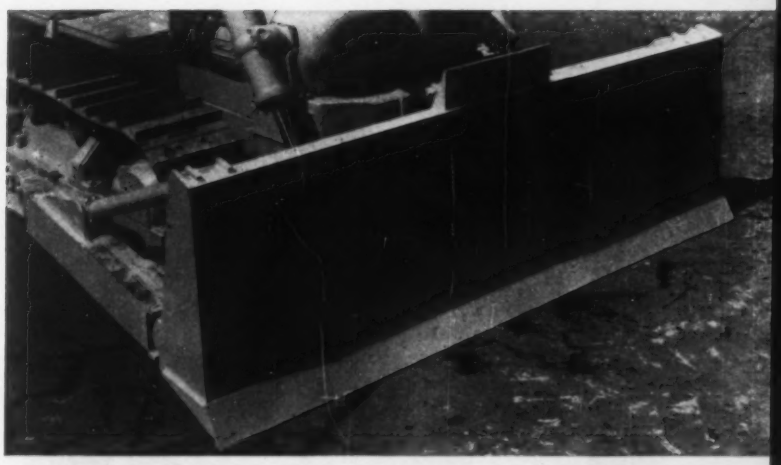
SUPER ALLOY STEELS • CONSTRUCTIONAL ALLOY STEELS • HIGH STRENGTH ALLOY STEELS • BEARING STEELS • STAINLESS STEELS • TITANIUM • SPECIAL CARBON STEELS

REPUBLIC VACUUM-MELTED METALS are produced in 18- to 32-inch diameter ingots weighing from 4,000 to 20,000 pounds. These can be processed into billets, sheets, bars, strip, and wire to meet your precise requirements.

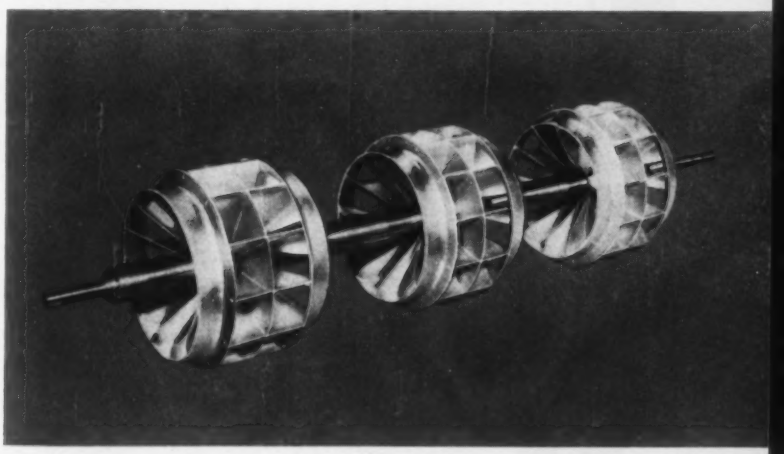
For more information, circle No. 421

Strong, Modern, Dependable

Steel



EXTREME TOUGHNESS: Grader and bulldozer blades are produced from Republic Hot Rolled Special Sections by Bucyrus Blades, Inc., Bucyrus, Ohio. Special analysis steel—proved on the job—gives uniformly high impact- and wear-resistance. Our technical people will be happy to show you how Republic's wide range of special section sizes and contours can be adapted to your particular product requirements.



CLOSE-TOLERANCE CONCENTRICITY: Buffalo Forge Company uses Republic ELECTRUNITE® Mechanical Tubing in the production of rotor shafts up to 94" long. Turning at 1,110 rpm, these shafts require exact balance to maintain high operating efficiency. Close-tolerance concentricity of ELECTRUNITE meets requirements without costly machining. ELECTRUNITE Mechanical Tubing is available in carbon and stainless steel. Mail coupon for details.

REPUBLIC STEEL

World's Widest Range
of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. ME-9749-D
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on:

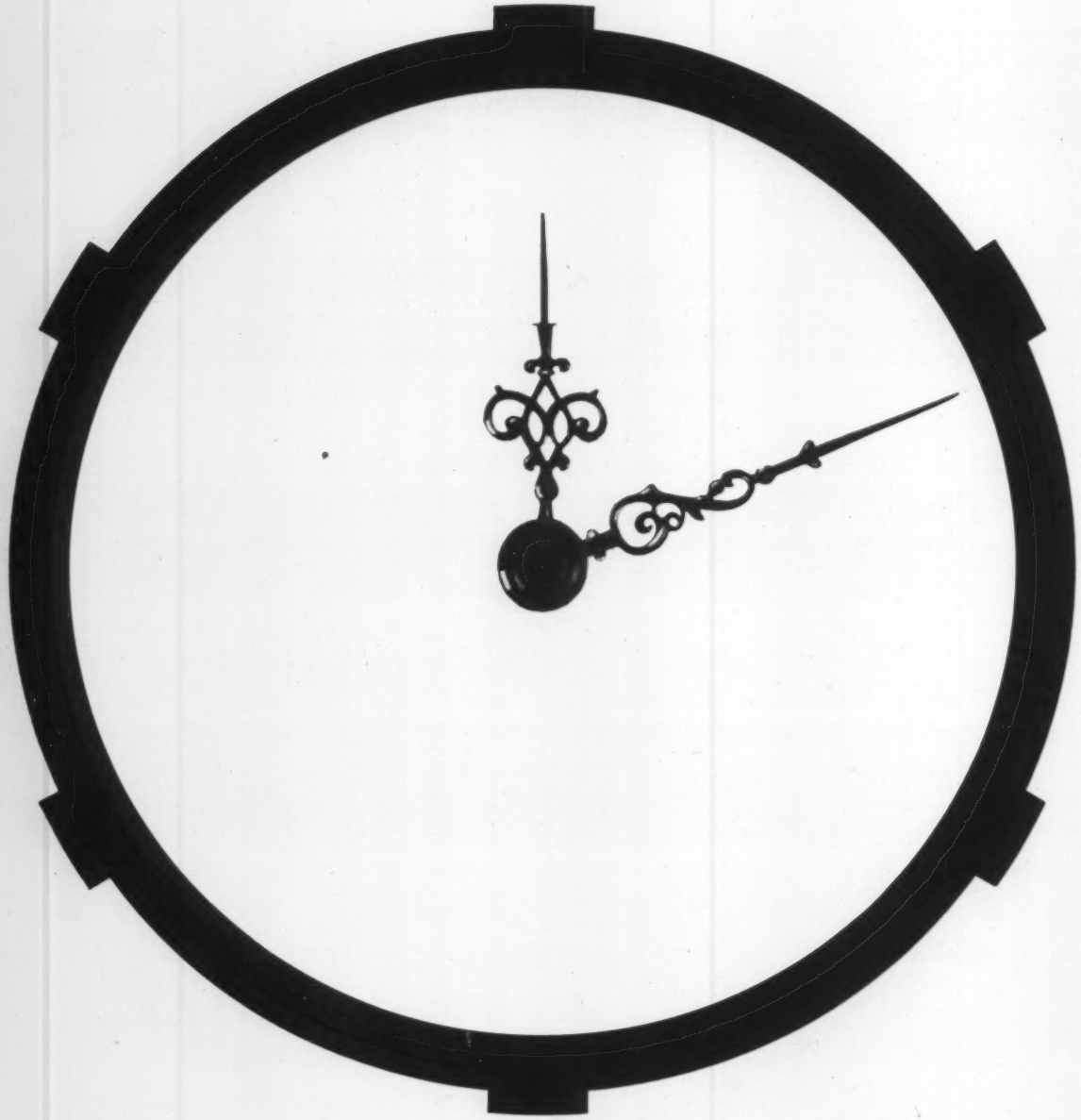
- ☐ Republic Vacuum-Melted Metals
- ☐ ELECTRUNITE Mechanical Tubing
- ☐ Have representative call to discuss Special Section requirements

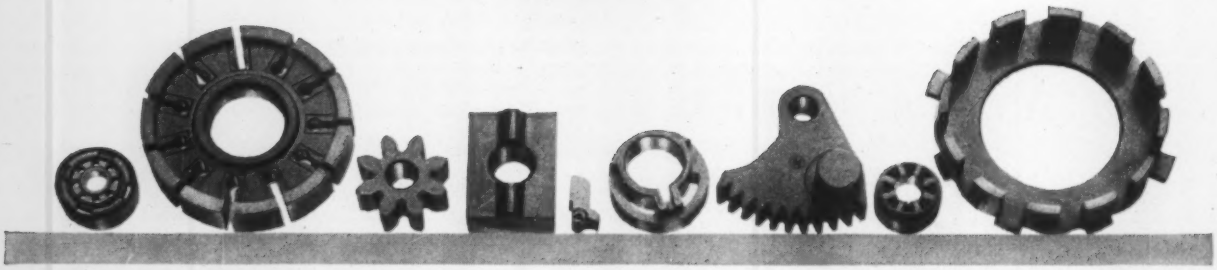
Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____





NEW MODEL? NEW PRODUCT?

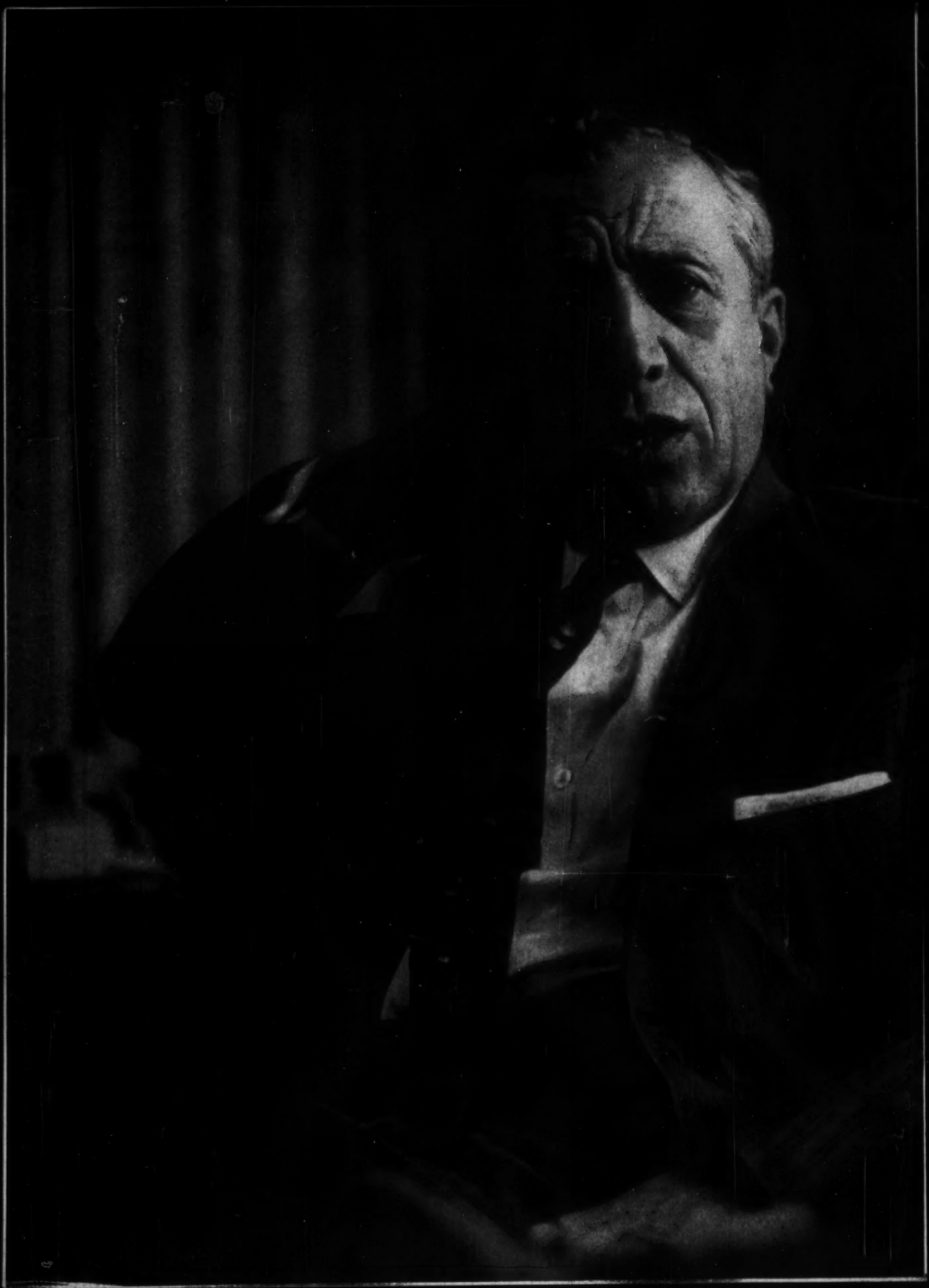
NOW'S THE TIME TO EXPLORE NEW SAVINGS WITH DELCO MORAINE SINTERED METAL PARTS

Designing or redesigning a product? Look carefully at components. If they're needed in quantity, Delco Moraine sintered metal parts may offer important advantages in cost, operating efficiency and improved reliability. It may be possible to design a single sintered part to replace a sub-assembly of several parts. Or eliminate the need for expensive machining operations. Or provide a special characteristic to lengthen product life, or improve performance. The controllable porosity of sintered metal parts, for example, permits impregnation with oil for lifetime self-lubrication. Give your new model or product every production break you can. Show components to engineers from Delco Moraine, a leader in the industry for forty years. They know when and how sintered metal parts can best be used. It's to your profit to know, too—and the best time to find out is now, in the planning stage.

DELCO MORAINE

Division of General Motors, Dayton, Ohio

For more information, turn to Reader Service card, circle No. 348



Joe Foster, President, indicates possible new applications for Nylon-6.

"Your competitors may be switching to Nylon-6 right now," says Joe Foster

Could be. It's worth thinking about.

For one thing's sure—Nylon-6 is one of the great molding resins, one that's bound to be popping up before long in exciting new applications. In portable electric mixers, maybe. Or transistor radios. Or electric shavers. Or even power tools.

But Nylon-6 should be part of your thinking for *several* reasons. Not just because of what your competition may or may not be planning, but because of what this remarkable fabricating material itself has to offer—a *unique combination* of advantages. Colorability. Non-flammability. Ease of molding and extrusion. Strength. Toughness. Abrasion-resistance. Impact-resistance. Flexibility. Heat stability. Self-lubrication. *And* the extra merchandisability of "Nylon" adds magic sales-power to all types of products.

As the world's largest manufacturer of sunglasses (with Nylon-6 frames) and a leading resin producer, we have great confidence in Nylon-6. That's why we recently acted to speed new applications, by reducing the price of Fosta® Nylon—our Nylon-6—to 98 cents a pound in quantity.

Like to find out more about Nylon-6? We'll be glad to send you current literature on Fosta Nylon. Just call us at KEystone 4-6511 or write Foster Grant Company, Inc., Leominster, Mass.

Your Partner in Plastics Progress

FG FOSTER GRANT

Plants in Leominster, Mass., Manchester, N. H., Baton Rouge, La.
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Also distributed by H. Muehlstein & Co., Inc., New York, N. Y.

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Count 'em, and you will find that 33 of the most critical parts in this fully-automated Anscomatic projector are made of Spencer Nylon.

It can pay you to learn why

There Are 33 Spencer Nylon Parts In This Precision Projector By Ansco:

The all-new Anscomatic® costs less, weighs less, wears less, and makes less noise — thanks to Spencer Nylon

When $119.50 buys a quality projector that will do "everything the magic of automation will allow," the manufacturer is to be credited with an engineering masterpiece. At Binghamton, New York, Ansco designers accomplished this feat when they introduced the new Anscomatic Projector.

Designing a complex machine like this requires efficient use of the most advanced materials available. That's why Ansco design engineers selected Spencer Nylon for 33 vital parts in this precision projector. Here are some of the ways in which Spencer Nylon helps Ansco deliver this unusual value:

Less cost — Parts of this type can be made of Spencer Nylon for less than using metals of comparable durability.

Less weight — Extremely lightweight, compared to metal, Spencer Nylon parts make the finished product easier to lift and reduce shipping costs as well.

Less wear — Tough, abrasion resistant Spencer Nylon is largely self-lubricating and free from the corrosion problems normally associated with metals.

Less noise — Metal-on-metal noises are eliminated when Spencer Nylon is used to replace one or both of the offending parts.

If your product presents problems of cost, weight, noise, corrosion, etc., you may well find the simple solution in parts of Spencer Nylon. Many leading manufacturers are finding that Spencer Nylon resins meet exacting standards even where other brands fail.

Why specify Spencer Nylon? No other nylon offers Spencer Nylon's "body," which is superior for extrusions involving complicated shapes. Also, Spencer Nylon contains far less water than other nylons — therefore, expensive drying time is unnecessary.

Without cost or obligation, you can consult with Spencer's technical experts concerning nylon parts for any of your products. Just contact Spencer Chemical Company at the address below:

SPENCER

SPENCER NYLON

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE — OR WRITE FOR COPY

SPENCER is also a prime supplier of

Poly-Eth Polyethylene

POLY-PRO POLYPROPYLENE

SPENCER CHEMICAL COMPANY, DWIGHT BUILDING, KANSAS CITY 5, MISSOURI

For more information, turn to Reader Service card, circle No. 432

R B & W FASTENER BRIEFS

MAKING THE MOST OF MODERN MECHANICAL FASTENING

Technical-ities

By Fred E. Graves

Fastening of "vibration" joints

With static assemblies, your only fastening worry is enough safe load capacity. But with dynamic loading, you also have to guard against loosening.

HIGH THREAD TENSION

You'll find one of the best locking mechanisms within the fastener itself: high thread tension. Obviously, the tighter the fastener, the higher the tension and the better the "lock."

CASE HISTORIES

(1) Textile looms notoriously suffer from vibration. Yet their bolts stay tight *without any locking device* when highly preloaded. (2) Heavy duty shakers had joint loosening problem which was solved for good when the maker switched to *high strength hex bolts torqued up almost to yield strength.*

Using split lock washers gives no such guarantee against loosening. It becomes equivalent to a solid washer at a relatively low load level. Once the screw has loosened to the point where the washer becomes a spring, it's too loose for safety.

When you can't fully utilize a high strength fastener, go to a bolt with prevailing torque lock nut; or to a unit that combines high thread tension along with a high off-torque value (such as RB&W's TENSILOCK fasteners—see Bulletin TL-2.)

With vibration joints involving thin gauge or sheet metal, it's better to use a *thread-cutting* screw, than a machine screw in tapped hole. It gives 100% depth of thread contact for more thread friction to resist backoff.

Some ideas for savings through cold forming

It generally costs less to cold-form a part than to machine it, since there's less scrap loss and more speed. The cold working strengthens the part, too—improves its physicals.

These four cases show what happened when designers and production men referred their needs in special parts to RB&W.

1. **Ball-head stud.** Formerly produced on screw machine, this truck mirror pivot suffered high scrap loss, cost 75% more than it did when RB&W produced it by cold forming and some secondary machining.

2. **Spacer.** Cost of this automobile trunk hinge spacer was cut 50% when RB&W cold-formers took on the job of pounding them out at high speed, finely finished and ready for installation.

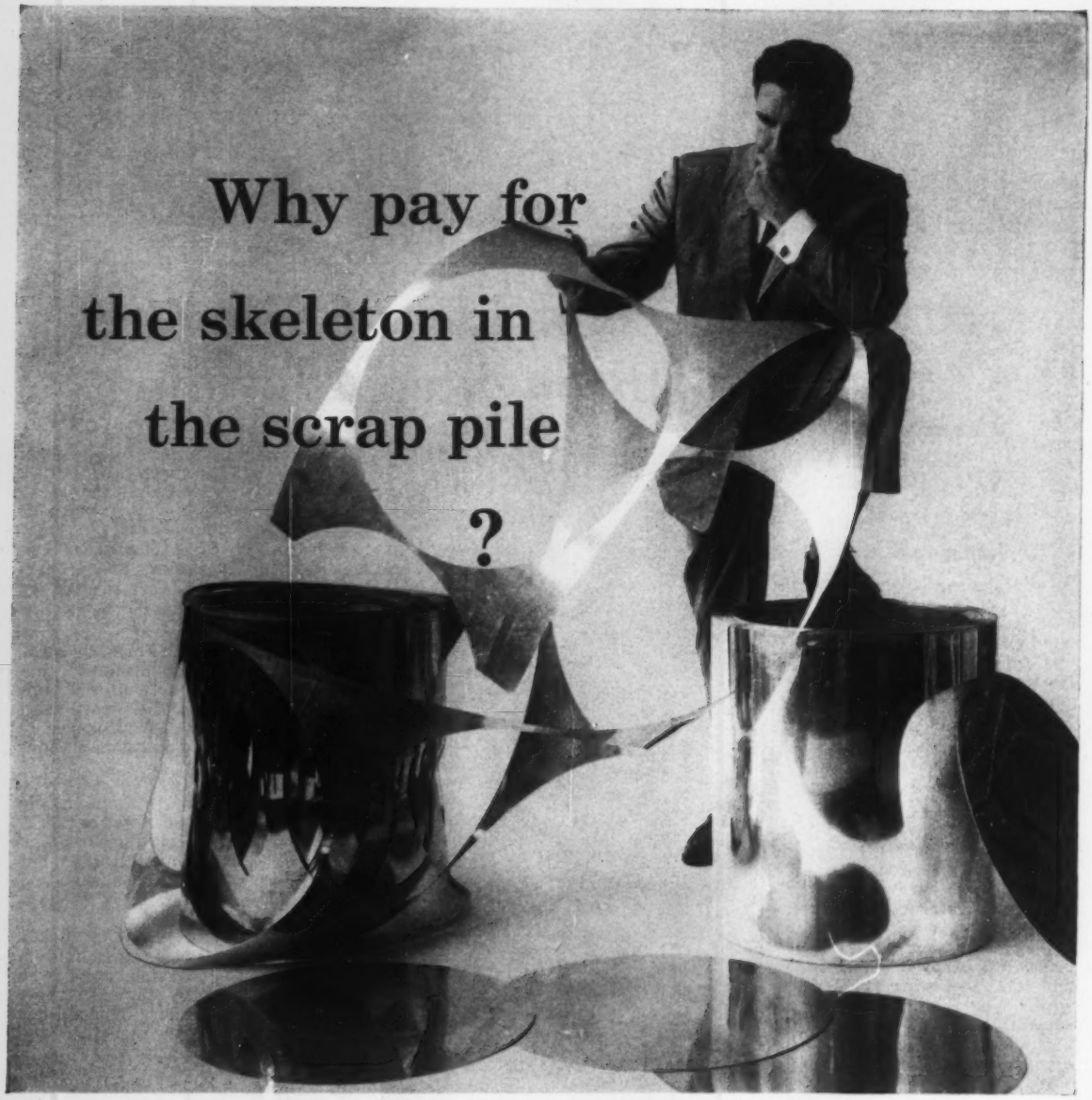
3. **Taper plug.** Time and money were both saved by manufacturer of expansion bolts who came to RB&W to make these parts. Cold headers formed them faster than screw machines, and with zero scrap.

4. **Adjustment cam.** Cold forming affords the *only* economically feasible way to produce this part. Due to its large eccentric and hex end, machining and material costs would be excessive.

These examples typify a range of work from RB&W cold heading and cold forming facilities. RB&W also performs many secondary operations on parts to specification, such as drilling, slotting, knurling, etc. Best way to see whether you have a part that could cost you less is to refer it to RB&W for study. Write Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, New York.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa., Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

For more information, turn to Reader Service card, circle No. 422



WHEN you stamp your own aluminum circles or any irregular blanks, up to 25% of coil weight ends up as scrap.

You can eliminate this waste—plus labor of shearing and blanking—by buying circles or blanks direct from Fairmont.

Fairmont is *the* source for circles. As a prime supplier of aluminum blanks to *every* utensil maker, Fairmont's 30-year stockpile of dies is unduplicated anywhere. Find out how easily we can fill your requirements from our stock of dies.

Or by blanking from your dies in our plant, we can effect labor, material savings for you.

Other Fairmont benefits: the consistent quality that is a Fairmont tradition . . . individual flash annealing for finer grain structure . . . 100% inspection of every blank.

FIND OUT ABOUT FAIRMONT'S CUSTOM BLANKING SERVICE NOW

A Fairmont engineer will be glad to give you details. Call your local Fairmont office. Or write Vice President, Sales, Dept. 25-L, Fairmont Aluminum Co., Fairmont, West Virginia.

FAIRMONT ALUMINUM COMPANY

subsidiary of CERRO DE PASCO CORPORATION

For more information, turn to Reader Service card, circle No. 357

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING

YES, WE HAVE NO GASKETS

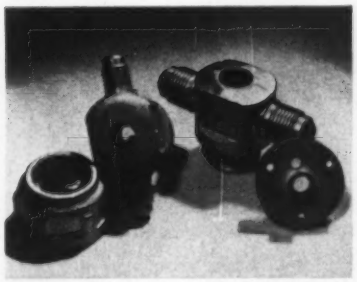
Gaskets cause countless problems in sight glasses, people told us.

Get rid of the gaskets, we replied.

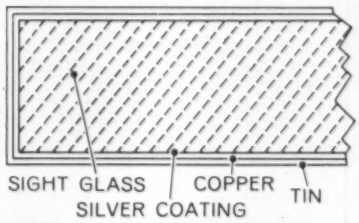
Show us how, they retorted.

So, we did.

Two ways.



One. We can and do make valve windows wherein the glass is fused directly to the metal without aid of gasket or solder. The result is a one-piece assembly with an heroically hermetic seal rated at 700 psi and bursting strength around 2500 psi.



Two. When it makes sense, we can and do metallize a glass with a base coat of silver, electroplate it with copper, and face it with a coat of tin which accepts soldering to a bezel, which we also can and do do. The finished window is rated to take 15 psi inside or out.

Since we are as versatile as the material we work with, we can pull such tricks as pressing configurations into the windows. We've already done things like bull's-eyes and indentations.

We had another job where we pressed an optical lens into a glass. The focal length of the lens is such that you get a reflection of light back to your eye, except when the unit is full of liquid, in which case you focus on the liquid itself.

Look into our windows whenever you find a gasket a nuisance, whether from temperature or pressure or corrosive environment or any of the many other conditions which tend to make gaskets a nuisance.

You can begin looking by sending the coupon.

ON ENCAPSULATING WITH PYROCERAM® CEMENT

Should you want to lift the thermal ceiling on encapsulated electronic parts as high as 700°C., you'll like what you see when you take a look at our PYROCERAM cement No. 45.

Certain people making coil cores for hot work are finding it almost ridiculously easy to meet such temperature specs while holding performance in all other areas.

The cement is almost completely impervious to vapors and chemically inert. It matches nicely to tungsten, molybdenum and other materials with a coefficient of expansion from 40 to 50 x 10^{-7}/°C.

This same cement can also be used for sealing glass to glass, metal to metal, ceramic to ceramic, or any combination of these materials.

There are two other PYROCERAM cements, both of which have a service temperature of 425°C. No. 89 lends itself well to platinum, vanadium, 50% nickel, and other materials with a coefficient of expansion 80 to 92 x 10^{-7}/°C. No. 95 is for chrome-iron stainless, Sylvania No. 4, and the like with a coefficient of expansion 90 to 110 x 10^{-7}/°C.

People who know say that the applications for this new material are ready to snowball. Perhaps if you send the coupon now, you will be first to use it in your particular field.

VYCOR® GLASSES AS WATER-GETTERS OR PROBE PROTECTORS

Put a piece of porous VYCOR brand glass into a humid environment and it drinks up 25% of its weight in moisture before becoming sated.

This has suggested its use as a substitute for desiccants to a number of people, particularly people who want a getter with unusual rigidity under stress conditions. Say, in a sealed inert-gas gyroscope, for example.

Others have seen in this same 96% silica glass a clean, long-lived semipermeable membrane.

Put a tiny tube of VYCOR non-porous glass around a pair of thermocouple wires and you have a device for reading the temperature of working melts of metals or anything else that runs from 2000 to 3000°F.

The tubes will stand up from four to six seconds even under this intense heat, keeping the wires intact long enough to get an accurate reading.

Actually, in practice these tubes are emerging from metal melts marred but still intact two times out of three! Since the glass is 96% pure silica, there's no threat of contamination to the melt even if the tubes should disintegrate.

All of which serves to demonstrate just two of the many amazing properties of the VYCOR brand glasses.

There's more about the various VYCOR glasses with their varied properties and the sizes and shapes we can deliver in a bulletin which is mentioned in the coupon.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 5012 Crystal St., Corning, N. Y.

☐ Sight Glasses ☐ VYCOR ☐ PYROCERAM Cement

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Company .....

Street .....

City ..... Zone ..... State .....

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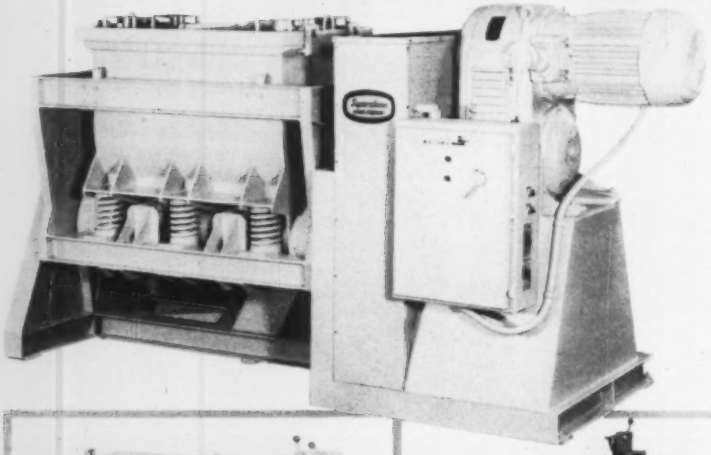
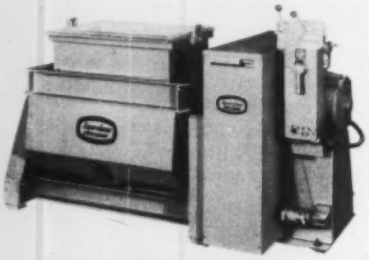
UP TO 100 TIMES FASTER FINISHING WITH

ALMCO VIBRASHEEN



ALMCO'S FULL LINE OF NEW VIBRASHEEN MACHINES

MODELS VT-717 — 712
(18 and 12 cu. ft. capacities)
Ideal for large components requiring fixtures or a large volume of smaller parts.

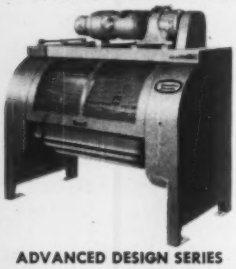


MODELS VT-77 — 75
(7 and 5 cu. ft. capacities)
Efficiently deburrs and finishes parts in quantities suitable for medium size production runs.

MODELS VT-72 — 71
(2½ and 1 cu. ft. capacities)
Popular unit for firms requiring precise finishing of a wide variety of parts in small lots.

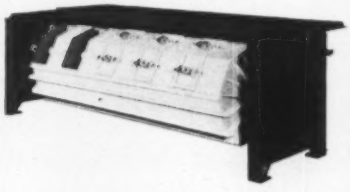
MODEL VT-70
(¾ cu. ft. capacity)
Bench model ideally suited for miniature bearings, extremely small gears, stampings, etc.

WORLD'S LARGEST LINE OF PRECISION FINISHING EQUIPMENT



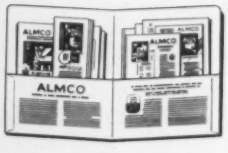
ADVANCED DESIGN SERIES
Thirteen models are available in this series featuring capacities of from 5 to 40 cu. ft., each equipped with variable speed drives. (Infinite from 6 to 30 rpm's.)

SPINDLE MACHINES
Designed for fast precision finishing of complex, high quality components such as gears, bearing cages, spline shafts, rotors, on continuous production "in line" basis.



CUSTOM DESIGN BARRELS
Special large diameter barrels are available to accommodate extra large parts. Fixtures hold parts to assure complete, precise finishing of all crevices and surfaces.

SEND FOR NEW ALMCO CATALOGS ON BARREL FINISHING MACHINES MEDIA, AND COMPOUNDS



ALMCO

PRECISION FINISHING

Queen Products Division • King-Seeley Corporation
312 E. Main Street, Albert Lea, Minnesota

For more information, turn to Reader Service card, circle No. 322

ENGINEERING & DESIGN

...AT A GLANCE

Electropolishing the surface of tungsten improves its ductility at room temperature, recent research shows. It is believed that polishing removes surface scratches and impurities that concentrate stresses. Subsequent scratching with a fine abrasive greatly reduces the ductility achieved.

Source: Technical Note D-304, National Aeronautics and Space Administration, Washington 25, D.C.

Redesigning automobiles using high strength steels can make them lighter, stronger and less expensive, a recent analysis shows. Underframes made of hot rolled carbon steel now weigh from 360 to 400 lb and the steel costs from $20 to $23 per frame. Redesigning the frames with any of approximately 30 stronger steels reduces weight 23% and cuts steel cost by 10%.

Source: United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.

Corrosion of metal parts is prevented during storage by heat sealing them in clear, polyester bags impregnated with a volatile corrosion inhibitor. The treated film releases an invisible vapor within the package that is said to prevent rust and corrosion.

Source: Daubert Chemical Co., 4700 S. Central Ave., Chicago, Ill.

Commercial corkboard is the best available nonmetallic insulator for liquid hydrogen tanks in rockets and spacecraft, recent tests show. It withstands surface temperatures of 1350 F and maintains a mean internal temperature of −200 F with less heat loss than glass fiber sheet, insulation-filled phenolic honeycomb or balsa wood. All were tested for thermal conductivity in the cryogenic range, and structural stability and ablation characteristics during aerodynamic heating.

Source: Technical Note D-476, National Aeronautics and Space Administration, Washington 25, D.C.

Ultrasonic cleaning removes soldering flux from aircraft bellows assemblies to uncover microscopic leaks. The flux often covered minute flaws in silver soldered joints while the units were subjected to mass spectrometer leak tests but then vibrated loose during operation.

Source: National Ultrasonic Corp., 111 Montgomery Ave., Irvington 11, N. J.

Continuous nuclear irradiation of polymers produces some reversible mechanical changes along with irreversible effects, according to recent Russian research. Decreases in mechanical strength, elasticity and creep rate are partially restored when irradiation ceases. The phenomenon is attributed to excited molecules, free radicals, electrons and ions that temporarily rupture the chemical bonds and cross-links of the polymer chains.

Source: Review of the Soviet Technical Press (Aug 5, 1960), Office of Technical Services, Washington 25, D.C.

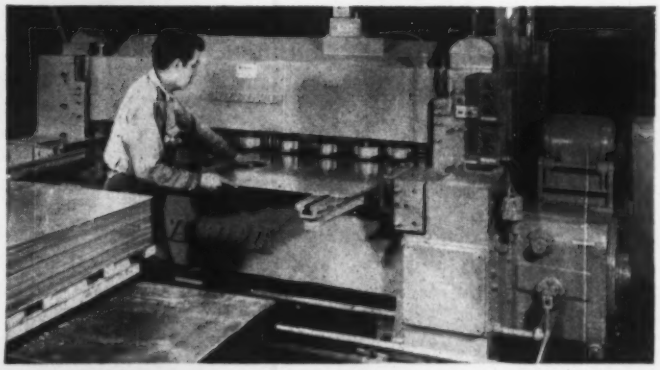
Metals that can be used with liquid fluorine are nickel and nickel alloys, stainless steels, aluminum, magnesium, mild steel, titanium, tantalum and zirconium. Except for very special applications, the only organic materials that can be used with either liquid or gaseous fluorine are the fluorocarbons. Nickel alloys can be used up to 1200 F, aluminum to 900 F, and copper to 700 F.

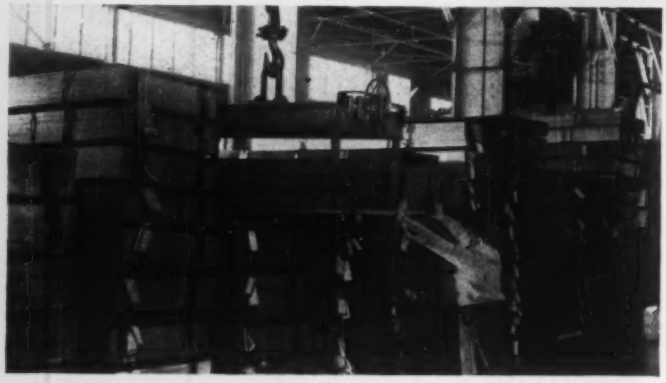
Source: E. L. White and others, Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.

How Ryerson gives you EXTRA VALUE IN SHEET STEEL

Carbon control—Did you know that Ryerson can furnish a conformance report, if requested when your order is placed, certifying that hot or cold rolled low carbon sheets in stock sizes are SAE 1008 with maximum carbon content of .10? This means you can minimize or eliminate problems of variation in formability and weldability.

Closest cutting tolerances—Our standard "aim" tolerances are the closest in the industry. For example, on shearing of sheets: width or length tolerance—under 48″, -1/32″; 48″ and over, -1/16″. These limits can be guaranteed upon specific request, given in advance of processing your order.





Fast, dependable service—Hundreds of customers often cite these two major reasons for ordering from Ryerson: absolute confidence in "dependability of service as promised," and speed of service to meet their most critical requirements.

Whatever your sheet and strip requirements, a Ryerson specialist is ready to consult with you. A phone call is all it takes.

METALOGICS
RYERSON PLUS VALUE

STEEL • ALUMINUM • PLASTICS • METALWORKING MACHINERY

RYERSON STEEL®

Joseph T. Ryerson & Son, Inc., Member of the INLAND® Steel Family

PLANT SERVICE CENTERS: BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DETROIT • HOUSTON • INDIANAPOLIS
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For more information, turn to Reader Service card, circle No. 423

The Chemistry of Materials Failure

Materials specialists and engineers tend to analyze product failure from different viewpoints. However, it can be shown that product failure is determined essentially by chemical action. Knowledge of the basic factors involved will help you determine if a failure-causing action will occur and how fast it will proceed.

by A. H. Bushey, *General Engineering Laboratory, General Electric Co.*

■ When a designer or engineer is asked for reasons why a product failed he is inclined to comment, "The design was inadequate." . . . "Service conditions were too drastic." . . . "The part was grossly mishandled." . . . "The maintenance people nowadays don't know what they're doing."

The chemist or metallurgist approaches the problem of product failure from a different direction. To him, failure occurred because some change took place in the materials composing the device. This change may be strictly physical, such as bending or breaking; it may be a physical-chemical change, such as melting or recrystallizing; or it may be a direct chemical reaction, such as corrosion or molding.

As the accompanying list shows, there are many different changes that can lead to materials failure. The purpose of this article is to review the basic factors that underlie and control these changes, and to explain what determines whether or not a given change can take place and how fast it will occur.

A Material Can Fail Because It . . .

- Bends
- Breaks
- Freezes
- Melts
- Vaporizes
- Corrodes
- Softens
- Sticks
- Burns
- Chars
- Dissolves
- Changes color
- Changes transparency
- Gains, or loses, conductivity
- Conducts, or fails to conduct, heat
- Develops friction
- Gains, or loses, porosity
- Ionizes, or fails to ionize
- Hydrates, or dehydrates
- Loses magnetization
- Changes viscosity

When will a material react?

Given a material or combination of materials is there any measure of its tendency to change? Yes, a quantitative answer is given by thermodynamics.

Every change in a material is accompanied by a change in energy. This energy change is specific for each given reaction and is independent of intermediate steps. The total energy change is made up of three elements:

1. *Work* done on or by the materials system resulting from a change in volume working against the pressure of the environment

2. Energy associated with the inherent tendency of atoms and molecules to want to assume a more random distribution. This is the so-called *entropy* factor.

3. Residual energy left over from the total energy change in the reaction. This is the *free energy* term. Under ideal conditions, such as a reversible action, all the free energy is available to do work; otherwise part or all appears as waste heat or other forms of energy.

Thus, combining the above three elements:

Total Energy Change = Work Term + Entropy Term + Free Energy Term.

The importance of free energy

The free energy term provides the numerical basis for classifying the reactive tendency of a materials system. Free energy must be lost by a system if a spontaneous reaction is to occur. Conversely, if a free energy gain is required, spontaneous action cannot occur.

Standard tables are available for use in calculating the free energy for a large number of possible reactions and thus determining the reactions that may or may not take place. For example, following are values of free energy change (denoted by ΔF) for some typical metal reactions. All values of ΔF are in kilocalories per gram molecular weight.

$Mg + H_2O \rightarrow MgO + H_2$; $\Delta F = -78.7$

$Zn + H_2O \rightarrow ZnO + H_2$; $\Delta F = -19.4$

$Hg + H_2O \rightarrow HgO + H_2$; $\Delta F = +46.2$

Magnesium and zinc can react spontaneously with water because there is a free energy loss. However, mercury cannot react spontaneously with water because free energy has to be added (note the plus sign) to the system in order for a reaction to take place.

How temperature affects free energy

Temperature has a pronounced effect on free energy change and hence on reacting tendency. In the reaction between zinc and water, for instance, the following typical free energy values apply at different temperatures:

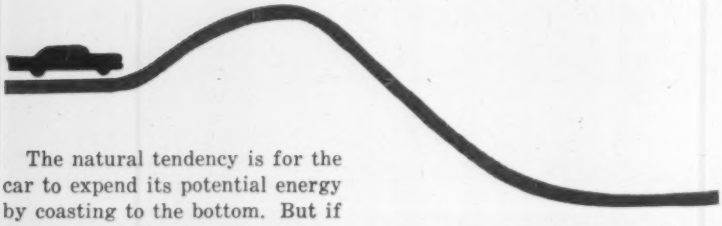
Temp, F	Free Energy, F
77	—19.4
1832	—8.5
2264	0.0

At the lower temperatures zinc corrodes but at 2264 F there is no tendency for reaction.

How fast will the change in the material proceed?

Free energy determines if a reaction can take place and, if so, what is the tendency to do so. It does *not define the rate* at which the reaction will go. All but the noble metals *can* rust and all organic matter—animal, vegetable and other—*can* react to carbon dioxide and water. The statement, "Ashes to ashes and dust to dust" is undoubtedly the first thermodynamic principle ever formulated. Fortunately, however, the rate is generally slow.

The situation is comparable to the case of a car without brakes at the top of a hill:

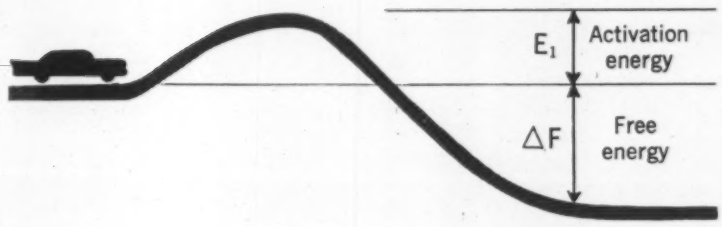


The natural tendency is for the car to expend its potential energy by coasting to the bottom. But if there is an obstacle in its path it might have to wait a long time. Only when it can borrow sufficient energy to be pushed to the top of the hump can it fulfill its ultimate destiny and coast to the lower level.

Still using our analogy, reaction rate depends on the statistical probability of getting a "push" and on the height of the "hump." Let us look first at what we mean by getting a "push" as applied to a reaction of materials. Specifically, we mean getting a quantity of energy to initiate the reaction. This energy may come from heating, radiation, concussion, electrical shock, or any other form. Indeed, it may come from a momentary concentration of the material's own heat energy; the molecules in a material are in constant motion, and some may have sufficient energy of motion to initiate a reaction. If we have a piece of iron exposed to air there is a definite probability that certain iron and oxygen atoms will have sufficient total energy to initiate the formation of an iron oxide molecule. Thus, the rate of the reaction is dependent on the probability that the reaction will occur.

The other factor that determines the rate at which the molecules of a material will undergo reaction is the height of the "hump" in our car analogy. This height is the *activation energy;* it is an inherent quantity for any given reaction and can be thought of as the energy necessary to push reacting molecules closely enough together to allow them to combine or to pull them hard enough to cause decomposition. If the activation energy or hump is high we can expect the reaction rate to be low; conversely if it is low we can expect the rate to be fast. Normally, we don't expect paper to catch fire without being ignited. Nevertheless, even without igniting paper will "burn" and deteriorate molecule by molecule with time until it finally crumbles.

Now we can definite our car-hill analogy in more detail. If the vertical axis represents energy, the net distance of drop is the ultimate tendency to react, i.e., the free energy. And the height of the hump is the activation energy (see next page):



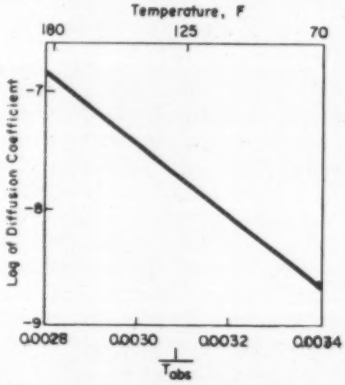
Arrhenius supplied, during the late 19th century, the empirical formula that relates rate constant, activation energy and temperature:

$$\ln K = -E_1/RT + C$$

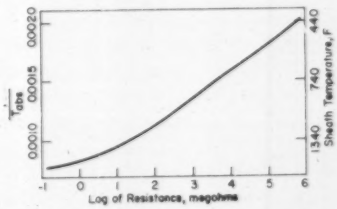
where E_1 is activation energy, R is the gas constant, T is absolute temperature, and C is a constant.

This familiar relationship between rate constant (ln K) and the reciprocal of absolute temperature can be applied to many materials reactions that require an input of energy to get started. A familiar example is evaporation, in which an escaping molecule requires more than average energy, i.e., an activation energy, to detach itself from the surface. Another example is the diffusion of water into a plastic material, Fig 1. The log of the diffusion coefficient gives a straight-line relationship with reciprocal absolute temperature. Similarly, Fig 2 shows the relationship between the log of electrical resistance of Calrod insulation with the reciprocal of absolute temperature. The change of slope in this case indicates a change of activation energy caused by a change in mechanism: conduction is believed to be ionic at low temperatures and electronic at high temperatures.

The Arrhenius equation is the basis for the familiar relationship that the rate of a chemical reaction doubles for each 18°F (10°C) increase in temperature. Obviously, this relationship is not absolute, but it has general application for many reactions of intermediate activation energy in the normal temperature range.



1—Diffusion of water into phenolic laminate shows straight-line relationship between log of diffusion coefficient and reciprocal of absolute temperature.



2—Relationship between log of electrical resistance of Calrod insulation and reciprocal of absolute temperature.

How can we use the above principles to help us understand how and why failure occurs? Here are four examples that show how chemical action determines radiation damage, corrosion effects, catalysis and mechanical failure.

How radiation affects materials

Radiation is energy and in interacting with matter it supplies heat. Of itself, it cannot induce a nonspontaneous reaction to take place, but it can supply the free energy necessary to drive a reaction forward. Furthermore, it causes a temperature increase that greatly accelerates the *rate* of any reaction that may occur. However, this situation is not the same as exposing material in a furnace. To see how it differs we must take a closer look at the concept of temperature.

Physically, temperature is defined by $E = 3/2\ kT$, where E is the translational energy of a molecule, k is Boltzmann's constant, and T is absolute temperature. Thus, temperature is measured by the molecular energy of motion or by $\frac{1}{2}\ mv^2$ (m = mass of molecule, v = velocity). Hot bodies cool because of the collision between high energy molecules and cooler lower energy molecules. Similarly, hot objects cause burns because the high energy molecules collide with our flesh and provide sufficient activation energy to cause it to decompose to a lower free energy state.

The same transfer of energy occurs when photons of radiation are absorbed by matter. But these photons are concentrated bundles of energy. When they are absorbed by matter they expend their energy in a very tiny region, and these regions are therefore momentarily raised to extreme temperatures. As a consequence, any reaction that can occur at these temperatures may do so in a local region. Typical of such reactions are sunburning and the degradation of plastics.

With high energy radiation—nuclear and x-ray—the effects are magnified many times. Instead of bundles of a few electron volts the bundles are thousands or millions of electron volts. Utter chaos oc-

curs when one of these high energy particles expands its energy in a volume of molecular size. Molecules are ripped apart, atoms are ionized, and debris is scattered about. Finally, the fragments combine in whatever manner is available, sometimes forming products with greater free energy than they originally had.

To place radiation effects in the proper perspective we need to recognize several factors.

First, total radiant energy is normally small: 1 gm of radium releases only 2 cal per hr. The gross effect on matter is therefore small. However the energy is delivered in highly concentrated packages and is released into minute volumes of matter.

On a gross scale, therefore, the material suffers not from the massiveness of the blow received but from its vital nature. The myriad of dislocations and reformed bonds can have a significant effect on bulk properties. In metals the net result is commonly to produce dislocations and defects in the lattice structure, comparable to cold working. In organic matter the result may be degradation or, as in the case of polyethylene, polymerization.

Finally, the effects of radiation are related to the energy of the bombarding photons. Visible radiation acts on only a few sensitive materials (such as a photographic plate). Nuclear radiation exerts itself on any matter that gets in its path.

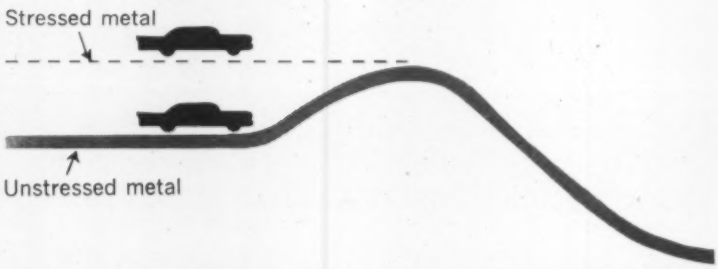
The basic chemistry of corrosion

Corrosion is a reaction between two materials that is initiated by overcoming an activation energy barrier. Corrosion occurs spontaneously if it is accompanied by a release of free energy, or it can be driven forward by externally applied energy. The reason it is such a troublemaker is that all metals except platinum, gold and the other noble metals lose free energy in oxidizing and thus can oxidize spontaneously.

Corrosion falls into two categories

Examination of corrosion literature reveals that there are a seemingly endless number of types of corrosion. However, these types of corrosion fall readily into two categories: those concerned with the corrosive agent, and those concerned with the source of activating energy. Since the effects of corrosive agents (such as acids and alkalis) are well-known, let us confine our attention to types of corrosion that are triggered by an input of energy.

Stress corrosion is a good example of corrosion set off by an input of energy. In this case cold working or other processing introduces stresses that are a source of stored energy in the metal lattice. Because of this lattice energy the metal tends to corrode more rapidly. In terms of our analogy with the car, the stored energy serves to raise the initial elevation of the car so that there is a greater probability that the hump or energy barrier will be overcome and a reaction will start:



Galvanic corrosion occurs when two dissimilar metals are in contact with each other and immersed in a liquid medium. During galvanic corrosion there is a tendency, directly dependent on free energy, for the following process to occur: 1) the more active metal to dissolve, 2) hydrogen to be released at the surface of the less active metal, 3) ions to migrate from one metal to the other through the solution, and 4) the electrical circuit to be completed by electron flow from one metal to the other through their common junction. This action can be reversed to protect metals against corrosion. Thus, if iron is coated with a layer of zinc (i.e., galvanized) the more active zinc is preferentially dissolved, thereby preventing attack on the load-bearing iron structure.

Galvanic action can also occur between surface areas of the same metal if one part of the metal is under stress—that is, has higher free energy. In this case the stressed area dissolves into the liquid. Likewise, galvanic action can occur if the solution contacting one area differs in composition from that contacting another area. A difference in free oxygen concentration in aqueous solutions is particularly bad in promoting this type of action.

Prevent corrosion by minimizing energy transfer

One way to prevent corrosion is to use noble metals such as platinum that, because of their low free energy, do not corrode. Another way is to hermetically shield the metal from corrosive agents with which it might react. Both of these approaches are costly and can be used only in extreme cases.

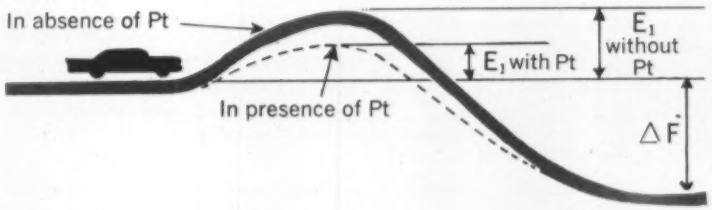
Beyond these drastic measures the best we can do is to understand what we are dealing with and use this knowledge to minimize the corrosion rate. Any moves to reduce exposure to acids, alkalies, moisture, chlorine, or other corrosive agents are helpful since, at lower concentration levels, both the rate and the free energy change of the reaction are lower. A reduction in temperature will also lower reaction rates substantially. Furthermore, couples between active and inactive metals should be avoided unless the active metal is purposely added for sacrificial protec-

tion. Finally, we can cover the surface with a paint or oil film and periodically apply fresh coats as the original coat reacts and deteriorates. In this connection many metals, such as aluminum, assist us greatly in that they develop a tenacious oxide film that blocks further action if we do not abrade it away.

Catalysis promotes reactions

"Catalysis" stems from a Greek word meaning "loosen." Chemically, it refers to a reaction in which some material—a catalyst—speeds up the reaction without itself taking part.

An excellent example of catalysis is the platinum sponge cigarette lighter in which alcohol vapor and air pass over an unheated platinum surface and burst into flame. The material and the action do not change the free energy (ΔF). However, the platinum surface permits a different mechanism of reaction which has a lower activation energy; so low in fact that the reaction takes place at room temperature. In terms of our analogy:



Catalysis is important in product design because it can promote reactions on metal surfaces. Thus, a catalytic surface can induce combustion products in the air to undergo reactions, e.g., change to acids, and it can accelerate attack on metals.

The very existence of a phenomenon such as catalysis should be a warning against treating materials problems in a routine way. The intelligent engineer should select his materials with care and with full consideration of the ultimate service environment to be encountered.

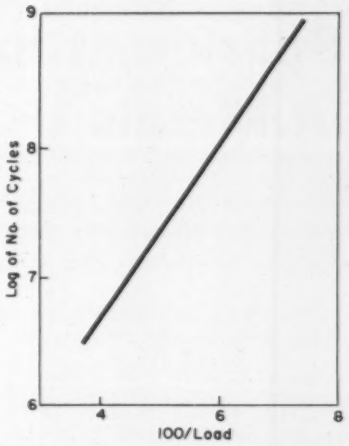
Do energy principles apply to mechanical failure?

Mechanical properties are mostly concerned with the gross behavior of material and it is gross properties that are commonly measured. However, behind any changes in tensile strength, creep rate, elasticity, etc., there will have been modifications in molecular interaction, and these modifications are definitely related to the principles under discussion. A few examples will help explain.

The effects of temperature

The first example was supplied by a materials specialist who was reviewing the design of a high temperature device made of zirconium. The materials specialist asked if the designer had taken into account the phase change of zirconium which takes place at about 1580 F. The designer asked what difference that would make! One can readily see the difference if he examines the change in properties of zirconium as it is heated past the transition temperature; there is a change in expansion coefficient, resistivity, hardness, tensile properties, and many others. The fact is that above 1850 F the free energy change for the transition becomes negative and a new material is formed.

There are an endless number of such pitfalls—was there ever a designer or engineer who did not fall into at least one of them? Take another case, the redesign of a transmission mechanism. During the redesign a concerted effort was made to determine if any new materials could be used for the drive belt. Laboratory tests showed that belts made of



3—Fatigue test often shows straight-line relationship between log of cycles to failure and reciprocal of load.

a thermoplastic-type polyurethane elastomer had five to ten times the life of conventional rubber belts, and polyurethane belts were subsequently introduced. However, designers did not take account of the fact that the tensile strength of the material falls off rapidly with increasing temperature. Thus, failure occurred when jamming of the driven shaft caused the rotating belt to heat up because of friction and so lose its strength.

Relating life to temperature and fatigue to load

Just as the Arrhenius equation supplied a relationship between reactive rate and temperature, so it may relate service life to temperature. Thus, in many cases:

$$\ln (\text{life}) \equiv 1/T_{abs}$$

It is possible to go even a step further by concluding that "cycles to failure" in a fatigue test is proportional to "life," and that "temperature" is a stress that may be related to "load" in a fatigue test. In this case:

$$\ln (\text{cycles to failure}) \equiv 1/\text{Load}$$

As shown in Fig 3, this relationship can in some cases be applied to fatigue data. However, practical considerations and other factors often modify the relationship a great deal.

This article was adapted from part of the Reliability by Design Course for design engineers, sponsored by GE's Defense Systems Dept.

Sparking Characteristics of Metals Used in Tools

Steel hand tools, if handled carefully, are no more dangerous than so-called nonsparking tools in hazardous environments.

by Harold Bernstein and George C. Young,
Naval Weapons Plant, Washington, D. C.

■ Nonsparking hand tools are currently being used by the Navy in and around areas where inflammable and explosive substances (such as petroleum products, nitrocellulose and black powder) are stored and handled. Such tools are seriously deficient in strength and durability. Since the actual ignition hazards of friction sparks that might be developed by steel hand tools is a controversial subject, the Naval Weapons Plant (formerly Naval Gun Factory) developed the following information on sparking characteristics and ignition hazards of materials—both sparking and nonsparking.

How are sparks classified?—Sparks fall into three categories: friction, impact, and electrical. Friction and impact sparks result when two hard materials come into forcible contact with each other; electrical sparks are caused by a discharge between two bodies having different potentials. Friction sparks are classified into two groups: 1) low total energy sparks from hand tools; and 2) high energy sparks from mechanical tools such as drills and pneumatic chisels.

In the context of ignition of petroleum products or detonation of explosives, the friction spark is the most important type to consider.

IGNITION HAZARDS OF METAL TO METAL COUPLES

Metal Couple	Type of Test	Environment	Hazard
Steel and Steel	Drop Weight	8% Methane-Air	Nil
Steel and Rusted Steel	Drop Weight	15% Hydrogen-Air	Some
Steel and Rusted Iron	Unknown	Firedamp	Some
Steel and Zinc	Drop Weight	6% Methane-Air	Nil
Steel and Aluminum Bronze	Drop Weight	6% Methane-Air	Nil
Titanium and Steel	Drop Weight	6% Methane-Air	Great
Aluminum Alloy (no Mg) and Rusted Steel	Drop Weight	6% Methane-Air	Small
Aluminum—10% Magnesium and Rusted Steel	Drop Weight	6% Methane-Air	Great
Magnesium Alloy and Rusted Steel	Drop Weight	8% Methane-Air	Great
Light Alloys and Rusted Steel	Drop Weight	3% Pentane-Air	Great
Steel and Aluminum or Steel	Ballistic	7% Methane-Air	Some
Steel and Magnesium / Aluminum / Steel / Copper / Zinc / Lead	Ballistic	15% Hydrogen-Air	Great ↓ Small*
Aluminum Smears on Rusted Steel	Glancing Impact, 2-Oz Hammer	Methane-Air	Great
Zinc Smears on Rusted Steel	Glancing Impact, 1.5-Lb Hammer	Methane-Air	Nil
Steel and Beryllium Copper	Sliding Impact	PETN	Great
Steel and 310 Stainless Steel	Sliding Impact	PETN	Great
Steel and Copper Alloy (3% Si, 1% Mn)	Sliding Impact	PETN	Small
Steel and Lead	Sliding Impact	PETN	Nil

*Attributed to breaking up of the steel ball. There is no hazard from lead.

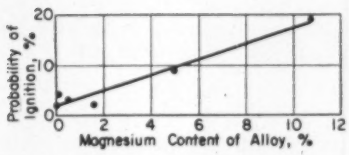
What tests show

Metal on metal

Metal-to-metal hazards of friction sparks are tabulated at left. Many types of metal couples and atmospheres are discussed. Here are some of the highlights:

Steel on steel—In experiments with steel on steel in a drop weight test, no ignitions were obtained in an 8% methane atmosphere. (Inclination of plate was 50 deg and height of fall 7.5 ft.) Another test showed that firedamp could be ignited by the impact of steel on steel. Considerable force was required and ignition occurred more readily when one of the colliding surfaces was very rusty.

Aluminum on steel—An aluminum alloy containing 13% silicon and 0.05% magnesium caused 13 ignitions in 40 tests (impact energy 313 ft-lb), and 15 ignitions in 60 tests (impact energy



***How magnesium content** affects incendivity of aluminum-base alloy. Alloy was drop-weight tested in methane atmosphere.* (After Titman)

366 ft-lb). With an aluminum alloy containing 10.7% magnesium, 39 ignitions were obtained in 40 tests at an impact energy test level of 366 ft-lb.

Magnesium (and alloys containing magnesium) on steel—Seven aluminum-base casting alloys, with magnesium content ranging from 0.05 to 11.0% were drop weight tested in a methane-air mixture. The probability of ignition was correlated with magnesium content as shown in the accompanying graph. In a similar test with a magnesium-base alloy (92.6% magnesium), probability of ignition was found to be 73.5%.

Effect of coatings

Coatings will not fully reduce the ignition hazard. A magnesium alloy with three different coatings —coated with pure aluminum, a synthetic resin and a thermoplastic material over the resin was drop weight tested on rusted steel plates. Although the ignition hazard of the magnesium alloy–steel couple was reduced by each of the three types of coatings, it was not eliminated.

Alloy smears—Smears of some light alloys on rusted steel surfaces can cause ignition of methane-air mixtures. Smears tested were aluminum and an aluminum alloy containing 4% copper, 4% silicon and 5% zinc.

Zinc alloy and aluminum bronze smears, tested under the same conditions, produced no sparks or flashes.

Painted surfaces—Rusted steel surfaces coated with aluminum paint develop incendiary sparks when struck while heated in the range 470 to 570 F. The heat necessary to cause ignition probably is developed in a thermit reaction between the aluminum and rust. A priming coat of red lead reduces the chances of sparking from aluminum painted steel surfaces. However, when red lead is added to the aluminum paint itself, the painted surface produces spark reactions which are almost explosive in nature.

What field experience shows

Tools that are accepted as the nonsparking type (copper, etc.) may actually dislodge a particle from a steel object which becomes incandescent and creates an ignition hazard. The term nonsparking, therefore, is a relative one and depends strongly on the metal couple being considered.

With petroleum — Although there is ample opportunity for the generation of sparks, the petroleum industry has experienced few fires caused by sparking of metal-to-metal couples. Heavy steel dome covers on tank cars are scraped around with considerable friction, and steel rods in derricks scrape metal components in the gaseous area of a producing well. The possibility of steel hand tools causing sparks is insignificant by comparison. The American Petroleum Institute recently advised the industry that steel hand tools could not be considered a safety hazard in the petroleum industry. However, mechanical tools such as pneumatic chisels can produce high energy sparks and are considered ignition hazards.

With explosives—A survey of naval establishments has indicated that no fires or explosions could be attributed to steel hand tools.

An Opposing Point of View

Although the work of Bernstein and Young indicates that steel hand tools, if used carefully, can replace nonsparking tools, experiments at the New York Naval Shipyard* present an opposing view. Since safety is the underlying issue, both sides of the argument are presented here.

Explosion chamber used

Experiments at the Shipyard used a steel explosion chamber containing an explosive atmosphere and a mechanical sparking system to test the ability of various metal-to-metal combinations to cause an explosion.

In the tests, a 3-in. dia, ¼-in. thick, coarsely knurled metal wheel, or a 2-in. dia aluminum oxide wheel, was rotated at 10,000 rpm against a ¼-in. dia, 2-in. long specimen held at a constant force of 2.5 lb against the rotating wheel. The object of the test was to develop a procedure for evaluating the sparking characteristics of metals.

*Rpt. PB 151650, Office of Technical Services, Dept. of Commerce.

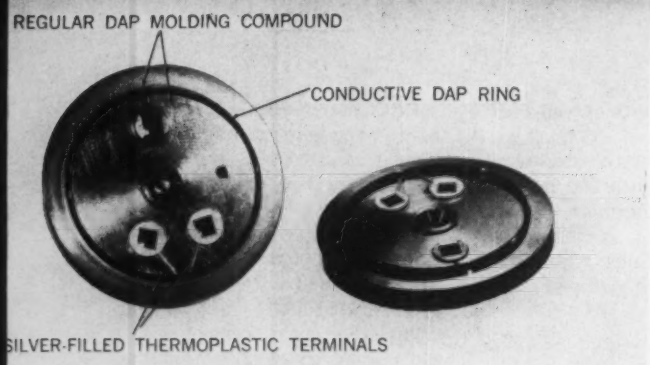
Ferrous metals unsafe

The investigators concluded that tools fabricated from carbon steel, stainless steel, carbon tool steel, high speed tool steel or monel are unsafe to handle in an explosive atmosphere of gasoline vapor.

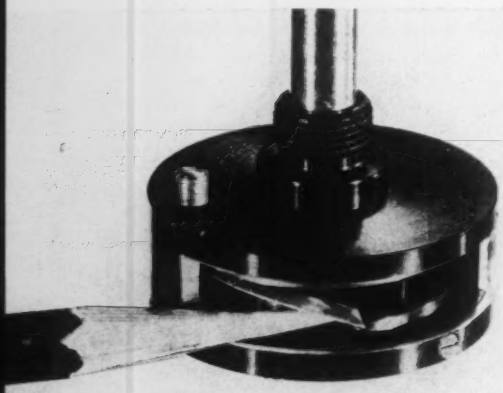
Conversely, tools fabricated from manganese bronze, phosphorus bronze, aluminum bronze, commercial brass, aluminum and beryllium copper are safe to handle in such an atmosphere.

The conclusions were based on these results:

1. Of 20 steel wheel and steel rod combinations and 4 abrasive wheel and steel rod combinations tested, all ignited the gasoline and oxygen-enriched air mixture.
2. None of the 35 steel wheel and nonferrous rod combinations or 7 abrasive wheel and nonferrous combinations, with the exception of 5 monel rod combinations, caused ignition.
3. None of 4 combinations using a rusted steel wheel and nonferrous rod combination ignited the mixture.



Disassembled potentiometer *showing conductive ring of carbon-filled diallyl phthalate (DAP) which substitutes for conventional wire-wound resistor. Terminals are silver-filled thermoplastic which cure during the molding cycle. Mold cycle for DAP is only 3 min as compared to 10 to 15 min for phenolics.*



Cutaway view *of potentiometer showing metal wiper riding on almost friction-free conductive ring. Housing is cast aluminum.*

Conductive Plastic Replaces Resistance Wire in Precision Potentiometer

■ Design engineers at New England Instrument Co., Waltham, Mass. have found that conductive diallyl phthalate (DAP) makes a good substitute for metal resistance wire in precision potentiometers.

Precision potentiometers are widely used in missiles and rockets, as well as control and servo equipment subject to vibration, shock and extreme humidity variations. Knowing DAP's excellent retention of electrical properties at high humidity (it absorbs almost no moisture), engineers reasoned that if the material could be made conductive it might make a good replacement for conventional wire elements which are susceptible to failure.

After considerable experimentation they developed a conductive compound using DAP (Dapon) and a carbon filler. As the photos show, this material is inserted into a recessed ring on the compression mold and covered with regular insulation-type DAP. Then the element and base are molded as one piece.

Use of the conductive DAP also has the advantage of reducing electrical noise (due to uneven surface resistance) by allowing the wiper to ride on the smooth, low-friction surface of the plastic. Wiper wear is reduced and turning torque made very low. The conductive DAP ring also gives the potentiometer "indefinite resolution": there are no jumps in resistance due to the wiper passing from one wire coil to another.

HOW THE DAP

1. ***Silver alcohol solution*** *is applied to the terminals on the mold face. Circular ring is receptacle for conductive DAP.*

2. ***Circular form is fitted*** *over the compression mold and a small amount of conductive DAP is put into recessed ring with a formed die. Pressure is closely regulated to insure uniform density.*

3. ***Conductive ring in place*** *after filling form has been removed. Following cleaning step, operator will remove tiny amount of conductive DAP between terminals. This void is filled with insulation-type DAP in next step.*

POTENTIOMETER IS MADE

4. ***Once again*** *a form is placed over the mold, and base is formed with insulation-type DAP. Each mold is closed by hand and inserted into the dielectric curing oven seen in the background. A slight flash is desirable to control density.*

5. ***Final assembly*** *base, with its integrally molded conductive DAP element (in operator's right hand), is joined to the wiper bearing housing. Silver terminals are inserted and joined with the terminal bases by peening.*

Slip Casting: a Good Way to Shape Difficult Materials

If your design problem is complicated by very complex shapes, brittle, hard-to-machine materials, etc., consider slip casting techniques.

by L. M. Schifferli, Jr., *Haynes Stellite Co.*

■ Slip casting will never replace more conventional powder metallurgy techniques. But its use as a supplement to conventional powder methods will continue to increase, especially in areas where its low tooling costs and wide design capabilities can be capitalized upon. Its chief limitations at present:

1. Powders needed for slip casting are more expensive than those normally required by other powder metallurgy processes.

2. Though many slip casting processing details are amenable to mechanization, most processing currently entails a large amount of expensive hand work.

This is slip casting

Slip casting is a technique well-known to ceramists. A liquid-solid suspension, or slip, of the material to be cast is poured into a plaster of paris mold of the desired contour. The liquid in the slip is drawn by capillary action into the plaster mold. Solids are progressively deposited until the desired wall thickness is built up on the mold surface. At that point the excess liquid is drained from the mold.

To produce a solid casting, the slip is constantly replenished in the mold as the liquid is drawn off into the plaster. Slip is added until a solid piece is produced.

The piece, hollow or solid, is left in the mold until evaporation and additional absorption remove some of the remaining liquid. The casting shrinks slightly during the evaporation process and releases from the plaster surface. The "green" part usually has enough strength to be removed from the mold for drying and sintering.

Why slip cast?

Consider slip casting when faced with these problems:

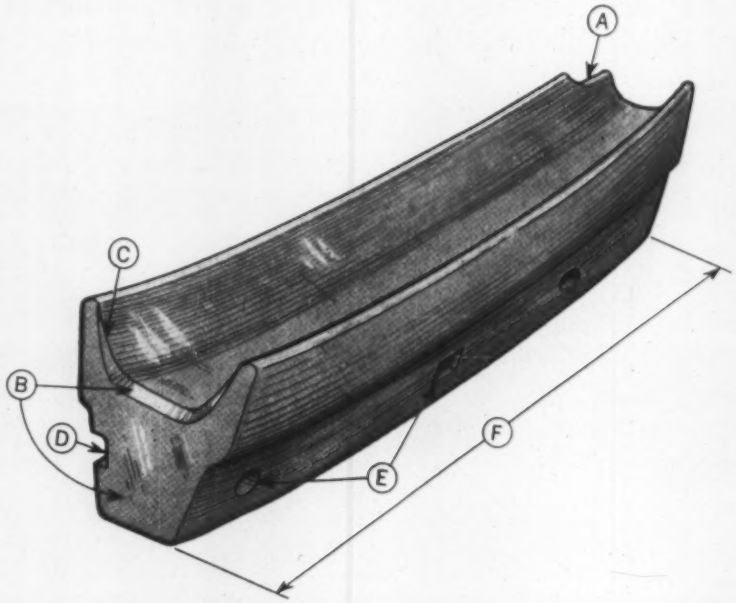
1. Materials with properties such as refractoriness, poor oxidation resistance, or brittleness which make conventional metallurgical methods such as melting, forging, welding, etc., difficult.

2. Designs which exceed the capabilities of common forming methods. Good examples of such designs are thin-wall closed-end tubes or complex shapes having reentry angles. Such forms are outside the capabilities of even the most advanced powder metallurgy methods.

In cases such as the two just mentioned, slip casting is the practical and economical method for producing many shapes from otherwise difficult materials.

What can be slip cast?

With few exceptions, it is possible to slip cast any solid material if it can first be reduced to



Designing for slip casting ***A****—Sharp corners should be avoided by the use of radii; minimum radius is 1/16 in.* ***B****—Ratio of difference in wall thickness on one piece should be no greater than 1:6. Minimum section size is 1/8 in.* ***C****—Edges should be chamfered to avoid chipping.* ***D****—Undercuts should be slightly taped.* ***E****—Core through-holes of any contour.* ***F****—Overall length is limited by sintering equipment and green strength of cast shape.*

at least a −100 mesh powder. The following materials have been slip cast with varying degrees of success:

1. Engineering metals: stainless steel, copper, beryllium.
2. Refractory metals: tungsten, molybdenum, tantalum, chromium.
3. Refractory metal compounds: tungsten carbide, molybdenum disilicide, silicon nitride, titanium carbide.
4. Mixtures: chromium-alumina cermets, stainless steel-uranium dioxide cermets, titanium-zirconia.
5. Nonmetallics: kaolinite, halloysite, montmorillonite, alumina, magnesia, thoria, silica.

The design potential

Slip casting has excellent design potential. The accompanying sketch indicates that overall configurations can be fairly complex. The discussion in the box below explains why slip casting makes some of the design features possible and what design limits for the process have evolved. Although the design specifications are applicable to a wide range of materials, final limits depend on the material that will be slip cast.

Seven Design Considerations for Slip Casting

1. Length

Length of slip cast parts is influenced by a number of factors. In general, size of a slip cast component will be limited to the maximum dimensions of the sintering furnace. Tubes, however, can be made longer, depending on service conditions. If a tube is needed which exceeds furnace capacities, consider brazing or threading shorter sections to fabricate a longer tube. If service conditions require a gastight component, these methods are not practical and other processes such as extrusion or welding must be considered.

Diameter of the cylindrical section also influences length of the slip cast part. A length-diameter ratio of 50:1 is well within the capabilities of the process; e.g., casting a tube with a ½-in. o.d. and 28-in. length is not considered difficult. When casting solid parts, the smaller the diameter the more fragile the piece will be in the "green" state. A long thin tube, for example, is difficult to remove from the plaster mold and place on proper sintering supports.

2. Width

It is difficult to place any design limit on width without knowledge of other required dimensions. On a production basis, ¼ in. thick, 11-in. square pieces have been made.

3. Thickness

Maximum wall thickness for tubes is limited to about ⅝ in., regardless of whether the piece is to be drain cast or cast with a core. For reasons not yet fully understood, the inside surface of drain cast ware having a wall thicker than ⅝ in. is wavy.

Tubes with a wall thickness greater than ¼ in. can be slip cast by using a core rather than draining the mold. Cores, usually made of plaster of paris, allow an accurate heavy wall thickness to be built up along the length of the tube. Very small tubes also can be cast using a core: a wire core was used to cast a 3-in. long tube with a ⅛-in. o.d. and 1/16-in. i.d.

Solid blocks 3½ in. wide and 5 in. long have been produced in thicknesses up to 1½ in.—the maximum thickness obtainable in slip cast products. Over this size, gating and feeding problems become formidable and poor recoveries, caused primarily by cracking, are experienced.

4. Radii and fillets

Slip casting is especially adaptable for fabrication of brittle, notch sensitive materials. If sharp corners in the design are eliminated by a fillet radius, high stress concentration points can be reduced. This is important from both the process and product viewpoints. Radii for corners and fillets should be made as large as possible and should not be less than 1/16 in.

5. Tolerances

Many variables are encountered in slip casting, each having an influence on shrinkage during drying and sintering, and consequently on tolerances. Depending upon the material, some pieces shrink up to 20% from pattern size to final size after sintering. Although no compaction forces other than gravity are used, the densities of unsintered shapes compare favorably with those of cold pressed compacts and, in addition, are considerably more uniform throughout the piece. Density differentials within a slip cast piece, which could result in wide variations in shrinkage, are rare. The most important variables influencing shrinkage are particle size, particle size distribution, and degree of defloculation. These are factors which, frankly, must be determined for each material being considered for the slip casting process. Once the variability of a factor is determined for a given material, the factor can be considered as a constant.

Impurities in the materials to be cast will vary the shrinkage rate from the green state to the sintered product. The state of the art is such that there are still a number of unknown factors which cause changes in product shrinkage. Research is in progress to determine why identical pieces, slip cast in an identical manner, vary in volume shrinkage.

Tolerances can usually be held to approximately 3% of blueprint dimensions, depending on size, shape, and whether or not the part is hollow or solid. If closer tolerances are required, standard finishing practices such as machining or grinding can be used.

6. Holes

Holes can be cored or drilled as required. Drilled holes, of course, are more accurate than cored holes but "chip-out" on the underside of the drilled hole is a problem. Blind holes are difficult to slip cast and are generally drilled.

7. Shapes can be cemented

In cases where it is impractical to slip cast a desired shape as one piece, it may be possible to cement a number of simpler shapes together. This is done when the shapes are still in the green state, using slip as cement. The procedure is not standard and, since it falls more in the realm of art than science, is expensive.

Which Heat Treatment for AM350

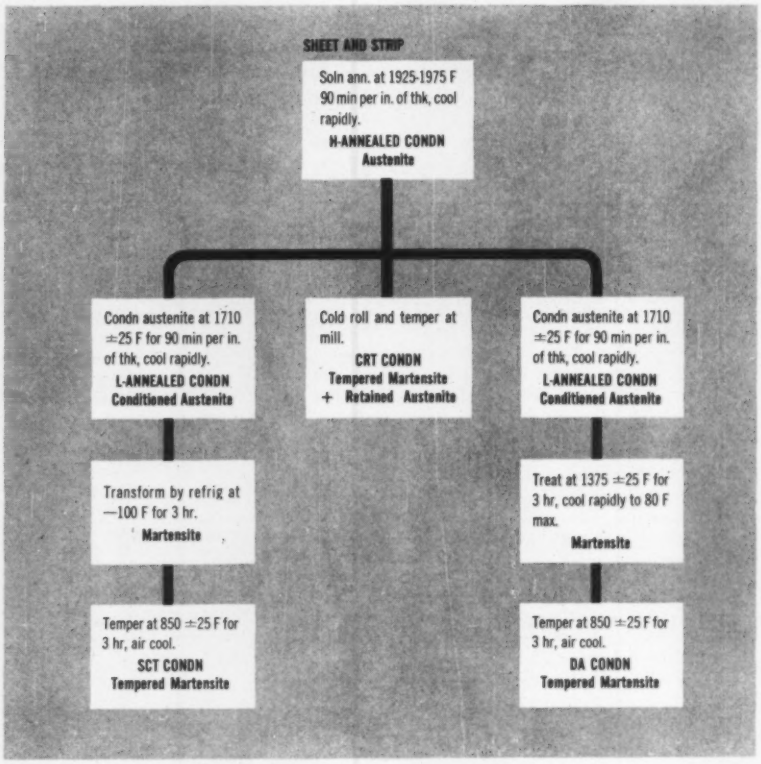
■ AM350 and AM355 are semi-austenitic stainless steels. The alloys are austenitic in the solution annealed condition, and their forming characteristics are similar to those of true austenitic stainless steels. A unique combination of strength, fabricability and corrosion resistance helps to explain the current popularity of these steels.

When the alloys were first introduced about six years ago, only two series of heat treatments were available: double aging (DA) and subzero cooling and tempering (SCT). Use of the DA treatment has declined, while SCT has increased in popularity because it results in better properties. Recently, new treatments which combine forming and hardening have been developed.

Note that treatments for these two alloys are not identical. As Table 1 shows, compositions of the two alloys are quite similar. Principal composition differences: the somewhat higher carbon content and lower chromium content of AM355 compared with AM350. Solution annealed AM350 contains 5 to 15% delta ferrite; AM355 is usually free of this constituent. Lack of nonhardenable delta ferrite in AM355 allows greater and more uniform hardening of this alloy but requires some modifications in its heat treatment.

TABLE 1—CHEMICAL COMPOSITIONS, %

Element	AM350	AM355
C	0.12 max	0.15 max
Mn	0.80	0.95
S	0.04 max	0.04 max
P	0.03 max	0.03 max
Si	0.50 max	0.50 max
Cr	16.00-17.00	15.00-16.00
Ni	4.00-5.00	4.00-5.00
Mo	2.50-3.25	2.50-3.25
N	0.07-0.13	0.07-0.13
Fe	Bal	Bal


SHEET AND STRIP
Soln ann. at 1925-1975 F 90 min per in. of thk, cool rapidly.
H-ANNEALED CONDN
Austenite
Condn austenite at 1710 ±25 F for 90 min per in. of thk, cool rapidly.
L-ANNEALED CONDN
Conditioned Austenite
Cold roll and temper at mill.
CRT CONDN
Tempered Martensite + Retained Austenite
Condn austenite at 1710 ±25 F for 90 min per in. of thk, cool rapidly.
L-ANNEALED CONDN
Conditioned Austenite
Transform by refrig at −100 F for 3 hr.
Martensite
Treat at 1375 ±25 F for 3 hr, cool rapidly to 80 F max.
Martensite
Temper at 850 ±25 F for 3 hr, air cool.
SCT CONDN
Tempered Martensite
Temper at 850 ±25 F for 3 hr, air cool.
DA CONDN
Tempered Martensite

Unscramble the alphabet to get proper condition

AM350 and AM355 can now be delivered to the user in any of six conditions: H, L, SCT, DA, CRT and SCCRT. By choosing the proper combination of treatments described in this section a wide range of mechanical properties, as shown in Table 2, can be obtained. Here is a simple explanation of the treatments shown on the flow charts:

H—*solution annealed*

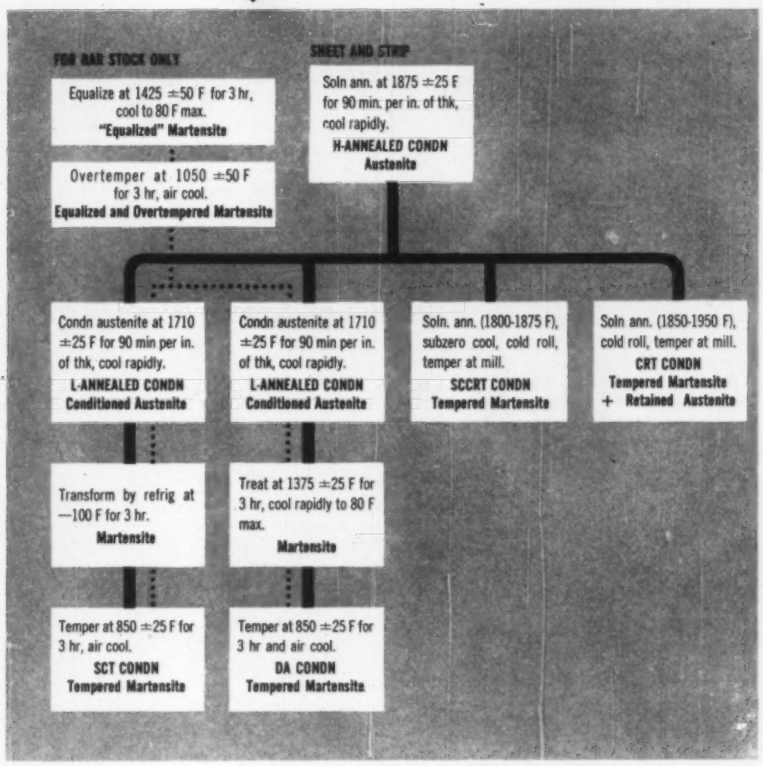
Thin sections of AM350 and 355 are usually supplied in the solution treated or H-annealed condition. AM350 is normally H-annealed at 1950 F. Because it lacks delta ferrite to limit elevated temperature grain growth, AM355 is H-annealed at 1875 F. At 1875 F, some carbide particles are not dissolved in the austenite and subsequently serve as sites for further carbide precipitation during hardening.

In the H condition, AM350 has an M_s temperature (start of martensitic transformation) which is well below room temperature. It is, therefore, soft, formable and not subject to transformation during winter shipment or storage. The M_s temperature of AM355 lies in the range 0 to 60 F, and the material must be kept warm when shipped or stored during the winter months.

Both AM350 and 355 are usually fabricated in the H-annealed condition. Since they are less

and AM355

These two useful stainless steels are available in six conditions offering a wide range of mechanical properties. Here is a guide that tells you what properties to expect from each treatment.


FOR BAR STOCK ONLY
SHEET AND STRIP
Equalize at 1425 ±50 F for 3 hr, cool to 80 F max.
"Equalized" Martensite
Soln ann. at 1875 ±25 F for 90 min. per in. of thk, cool rapidly.
H-ANNEALED CONDN
Austenite
Overtemper at 1050 ±50 F for 3 hr, air cool.
Equalized and Overtempered Martensite
Condn austenite at 1710 ±25 F for 90 min per in. of thk, cool rapidly.
L-ANNEALED CONDN
Conditioned Austenite
Condn austenite at 1710 ±25 F for 90 min per in. of thk, cool rapidly.
L-ANNEALED CONDN
Conditioned Austenite
Soln. ann. (1800-1875 F), subzero cool, cold roll, temper at mill.
SCCRT CONDN
Tempered Martensite
Soln ann. (1850-1950 F), cold roll, temper at mill.
CRT CONDN
Tempered Martensite
+ Retained Austenite
Transform by refrig at —100 F for 3 hr.
Martensite
Treat at 1375 ±25 F for 3 hr, cool rapidly to 80 F max.
Martensite
Temper at 850 ±25 F for 3 hr, air cool.
SCT CONDN
Tempered Martensite
Temper at 850 ±25 F for 3 hr and air cool.
DA CONDN
Tempered Martensite

stable than the true austenitic stainless steels, both alloys work harden more rapidly. The H-anneal is used if an intermediate anneal is needed to restore ductility.

L—*austenite is conditioned at 1710 F*

After fabrication, both AM350 and 355 can be hardened either by double aging or by subzero cooling and tempering. The L-anneal is the first step in these processes and consists of heating the metals to 1710 F. This step, which conditions the austenitic structure so that it can be made martensitic by cooling, allows all but 0.05 to 0.06% of the carbon to precipitate from the austenite in the form of chromium carbide particles. Precipitates form mainly at the austenite-delta ferrite boundaries in AM350 and at grain boundaries or around existing carbides in AM355.

DA—*Tempered martensite*

Treatment at 1375 F after the L-anneal causes even more carbon to precipitate from the austenite matrix: only 0.02 to 0.03% remains in solution after this treatment. Material treated at 1375 F transforms to martensite when cooled to room temperature. Tempering at 850 F to obtain final properties does not change the hardness significantly but does result in a rather large increase in yield strength.

TABLE 2—TYPICAL MECHANICAL PROPERTIES OF AM350 AND AM355 SHEET AND STRIP
(At Room and Elevated Temperatures)

	Ult Ten Str, 1000 psi						Yld Str (0.2% offset), 1000 psi						Elong (in 2 in.), %					
Condition →	H	L	SCT	DA	CRT	SCCRT	H	L	SCT	DA	CRT	SCCRT	H	L	SCT	DA	CRT	SCCRT
AM350																		
RT	155	165	210	195	232	—	55	55	180	157	217	—	36	20	15	10	15	—
600 F	—	—	200	185	215	—	—	—	140	135	178	—	—	—	8	6	11	—
800 F	—	—	195	179	204	—	—	—	135	123	164	—	—	—	10	11	14	—
900 F	—	—	175	159	—	—	—	—	125	112	—	—	—	—	12	11	—	—
1000 F	—	—	120	127	—	—	—	—	95	96	—	—	—	—	14	11	—	—
AM355																		
RT	186	195	220	188	234	290	55	60	183	153	215	280	30	15	13	13	20	2.5
600 F	—	—	200	175	202	267	—	—	150	130	171	254	—	—	8	8	7	1.0
800 F	—	—	190	169	186	252	—	—	125	117	149	237	—	—	9	9	8	3.5
1000 F	—	—	125	121	139	157	—	—	100	93	117	148	—	—	9	9	5	2.0

More uniform precipitation of carbides and, therefore, more uniform hardening, is obtained in material given the DA treatment if it is L-annealed prior to treatment at 1375 F. In AM355 the dual conditioning treatment is mandatory; in AM350, because it contains delta ferrite (which increases the number of carbide precipitation sites), the 1710 F treatment prior to the 1375 F treatment, although desirable, is not necessary.

SCT—*Cooled to −100 F, tempered at 850 F*

After the L-anneal, both AM-350 and 355 can be cooled to −100 F to transform austenite to martensite. Again, final properties are developed after an 850 F temper.

CRT—*Cold rolled, tempered*

One of the newer treatments used to harden AM350 and 355 is cold rolling followed by tempering. This sequence is performed at the supplier's mill and results in strength levels considerably higher than those developed only by heat treatment. Strength of the alloys increases as the degree of cold reduction increases, as would be expected. The increase in strength is gained at the expense of formability.

SCCRT—*Cooled to −100 F, cold rolled, tempered at 850 F*

The combination of treatments specified in this case is: subzero cool, cold roll and temper. Performed only on AM355 at the supplier's mill, this treatment also offers the designer greatly increased mechanical properties at the expense of formability.

Subzero cool or double age?

The higher mechanical properties of subzero cooled and tempered AM350 and 355, in comparison with double-aged material, account for the increase in use of the SCT treatment. The better corrosion resistance of SCT material shown in Table 3 is another advantage.

TABLE 3—CONDITION AFFECTS CORROSION OF AM350 AND AM355
(Corrosion Rates in In. per Year)

Environment ↓ Condition →	AM350		AM355	
	SCT	DA	SCT	DA
65% Nitric Acid (boiling)	0.014	0.065	0.03	0.04
Citric Acid (boiling)	0.00003	0.00002	0.0001	0.0004
Glacial Acetic Acid (boiling)	0.0004	0.0004	0.00007	0.0007
10% Phosphoric Acid (boiling)	0.0001	0.0001	0.0032	0.0137
10% Oxalic Acid (200 F)	0.02	0.02	0.04	0.04
½% Sulfuric Acid (100 F)	0.015	0.019	0.024	0.028

TABLE 4—TYPICAL MECHANICAL PROPERTIES OF AM355 BAR
(For Three Conditions)

Test Temp, F ↓	Tempering Temp, F ↓	Ten Str, 1000 psi			Yld Str (0.2% offset), 1000 psi			Elong (in 1.4 in.),%		
		E+O	SCT	DA	E+O	SCT	DA	E+O	SCT	DA
RT		157	—	—	130	—	—	18	—	—
	850	—	216	188	—	182	153	—	19	20
	1000	—	185	—	—	171	—	—	19	—
400	850	—	207	175	—	162	135	—	16	15
	1000	—	166	—	—	155	—	—	17	—
600	850	—	209	175	—	152	130	—	12	11
	1000	—	159	—	—	143	—	—	14	—
800	850	—	198	169	—	138	117	—	11	14
	1000	—	143	—	—	127	—	—	16	—
1000	850	—	144	121	—	97	93	—	15	19
	1000	—	115	—	—	97	—	—	18	—

Two other advantages of SCT material:

1. L-annealed material is largely austenitic when cooled to room temperature. Therefore, it can be re-struck in forming dies if the 1710 F treatment produces any distortion. Double-aged material is martensitic after cooling to room temperature: because of its higher mechanical properties (Table 2), DA material cannot be reformed easily.

2. When these alloys transform from austenite to martensite, they expand 0.0045 in. per in., an important factor in the design of fabricating operations. L-annealed material is almost completely transformed from austenite to martensite when stretch formed in amounts of 10% or more—eliminating the need for subzero cooling. In stretch forming the expansion due to the austenitic transformation is absorbed during the working operation.

Perhaps the only advantage offered by the DA sequence is that a reasonably good combination of properties can be obtained without the use of refrigeration equipment. Although the refrigeration chambers necessary are available in both ready-made and custom-made units, their cost may pro-

(continued on p 145)

MORE ENGINEERING & DESIGN

Synthetic ruby amplifies light 145
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Dense hafnium carbide is hot press formed .. 152

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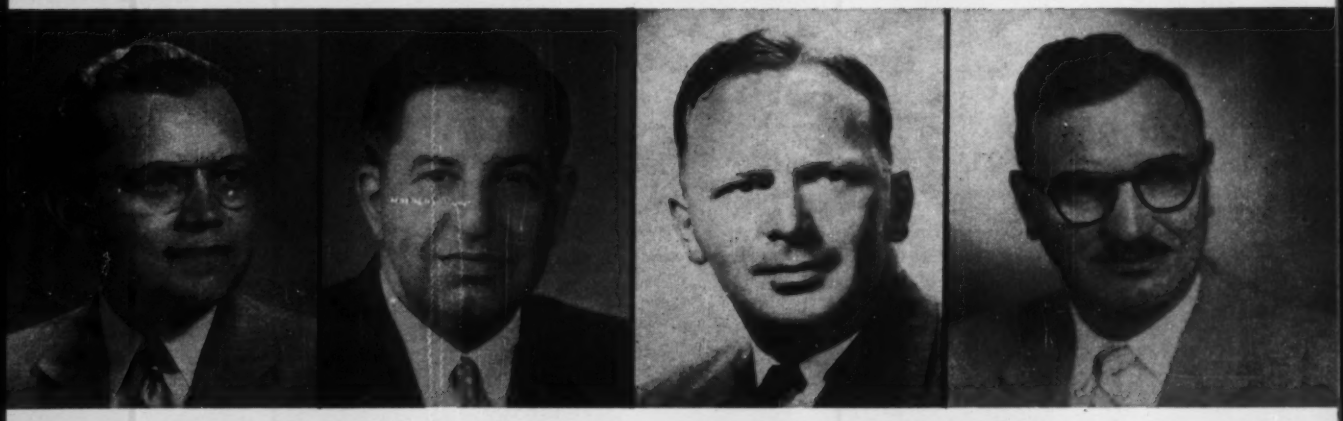

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1

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You can enter any part or product which you worked on, provided that: 1) You are employed in the product manufacturing industries, and 2) The design was completed during 1960 or the product went into production during 1960. An entry may be either a new product or a redesigned product that demonstrates sound, imaginative and progressive use of engineering materials. Engineering materials are defined as metals, nonmetallics, finishes and coatings, and material forms (such as castings, forgings, moldings, etc.). The product may be a complete assembly, a subassembly, a single part or a component.

Prepare your entry – it's easy

You need not write up your entry in the form of an article. Entries will not be judged for literary quality. See back page of this folder for details on the information that must be submitted with each entry.

Send in your entry by February 1

Entries must be mailed no later than February 1, 1961. Mail all entries to

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Materials in Design Engineering

5th ANNUAL AWARDS COMPETITION

for the Best Use of Engineering Materials

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Eligibility

Any person(s), department, group, or organization in the product manufacturing industries may submit an entry or entries. No one employed by a materials producer or supplier is eligible.

Preparation of Entries

1. The following information must be provided with each entry in order to allow the judges to make competent decisions:

a. A detailed description of the product including photographs or drawings. If the entry is a redesign, provide before and after illustrations if possible.

b. A description of requirements in service and/or fabrication that must be met by the product and the material.

c. A description of the previously used materials (if entry is a redesign).

d. A description of the material or materials selected for the product entry.

e. An explanation of why the material or materials were selected for the product. Describe the advantages or benefits gained through the choice. Back them up with evidence—facts, data, charts, tables on performance, quality or cost.

In general, entries should show that the materials selected for the product—

Resulted in improved performance and/or lower costs or
Best met the design and service requirements.

Here are a few ways in which a product can benefit from intelligent materials selection:

Long service life	Reduced scrap
Lower basic materials cost	Reduced or eliminated maintenance
Less material required	Permitted lower cost design
Improved appearance	Allowed greater design flexibility
Permitted a new design	Simplified production and fabrication
Reduced production costs	
Improved service performance	

Remember! The more detailed and documented your entry is, the more consideration it will receive from the judges.

2. Entries or portions of entries will not be returned unless requested. Entries should not include valuable papers or other material which must be returned, because there is always some danger of loss or mutilation. Whenever possible, photostats, photographs or other copies of such materials should be used instead.

3. All entries must be postmarked not later than **February 1, 1961.** The judges reserve the right to withhold awards at their discretion.

Publication of Entries

Materials in Design Engineering plans to publish articles on the winning entries and reserves the right to publish articles based on entries not winning awards.

NOTE: Please observe the rules given above. Use a separate blank for each entry; additional entry blanks available on request. Attach entry blank below, or its equivalent, to your entry and mail to:

Awards Editor, Materials in Design Engineering, 430 Park Ave., New York 22, N. Y.

Name _____ Title _____

Name(s) of person(s), group or organization who would receive award _____

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Name or brief description of product being entered _____

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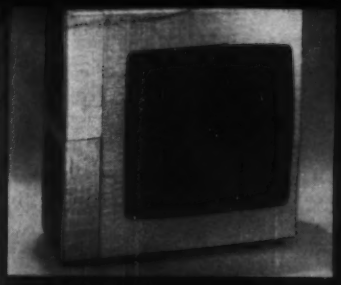
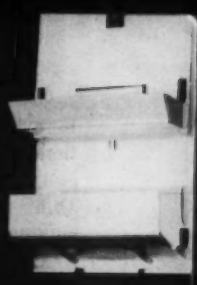
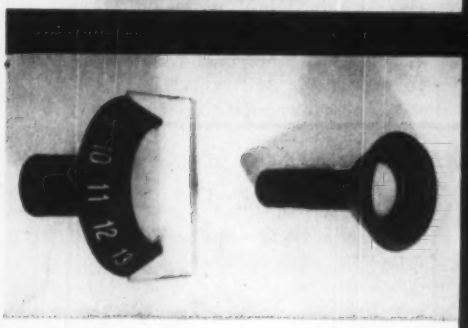
Was design (or redesign) of entry either completed or placed in production during 1960? _____

Does your employer consent to entry under terms of this competition? _____







M/DE Special Report
No. **178**
December, 1960

What Users Think of Polypropylene

by Malcolm W. Riley, *Associate Editor, Materials in Design Engineering*

One of the newest plastics, polypropylene has been widely publicized during the last three years and has found many uses. With an expanded supply imminent, it seems a good time to stop and try to appraise objectively the advantages and limitations of this material. Here is what we believe is a fair appraisal based on personal interviews with engineers who have applied polypropylene in their own products.

■ The most striking thing about the use of polypropylene is the care and judgment with which engineers and designers have evaluated polypropylene and put it to use. Misapplications are uncommon. Most uses have resulted from the need for a property or combination of properties provided by no other material at as low a cost.

But problems do exist. And, to some manufacturers (such as the automakers) who select materials only after a most critical evaluation of performance vs cost and availability, polypropylene is still a new material—interesting, but new.

Plus and minus in a nutshell

The plus side: From the end users' standpoint the reasons for selecting polypropylene most often mentioned are:

1. For its cost (42¢ per lb; 1.4¢ per cu in.) it has better resistance to heat and chemicals than any other thermoplastic material.

2. It has greater rigidity and strength than high density polyethylene, the only other low cost thermoplastic serviceable at temperatures higher than 212 F.

3. Its bulk rigidity is highly dependent on section thickness. Consequently, by altering section thickness in a part, you can com-

bine high rigidity with excellent flexibility.

4. It has excellent flex life in thin sections, permitting such unique parts as the integral hinge.

5. Its combination of rigidity and resilience permits stripping of undercut parts from molds with no permanent distortion.

6. Materials suppliers equipped with relatively well developed performance data have aggressively brought the material to the attention of end users.

The minus side: On the other hand, the problems most often mentioned by end users include:

1. Difficulty in successfully marking polypropylene moldings by painting or hot stamping.

2. Difficulty in getting smooth, high gloss, decorative surfaces over large flat areas on complicated moldings.

3. Some difficulty in extruding large profile shapes with good surface.

4. Lack of uniform processing and performance characteristics in supposedly comparable grades from different materials suppliers.

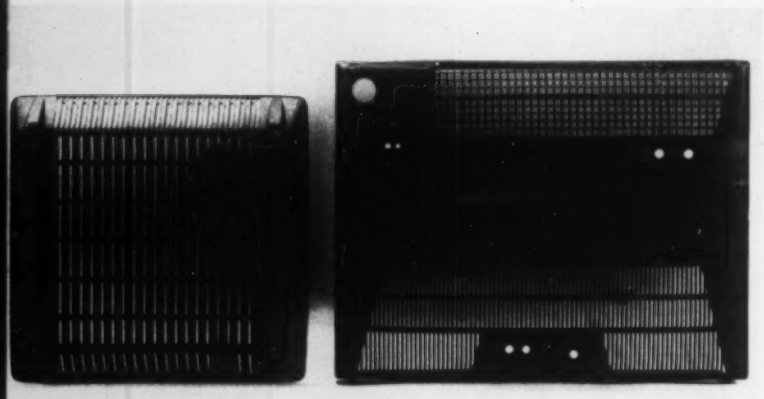
5. Lack of long-term performance data.

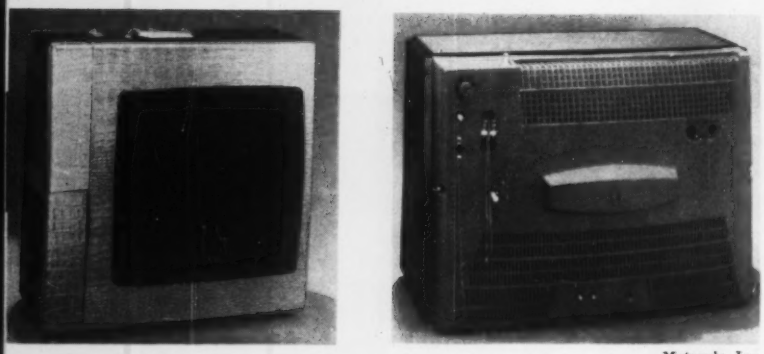
Has polypropylene been oversold?

Some observers of the plastics industry have felt that polypropylene has been oversold—that its benefits have been exaggerated.

None of the engineers or materials specialists interviewed for this article felt this was so. No users of polypropylene felt they had been promised anything they did not get—to a reasonable degree.

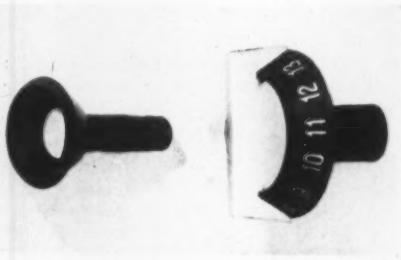
APPLIANCES . . .





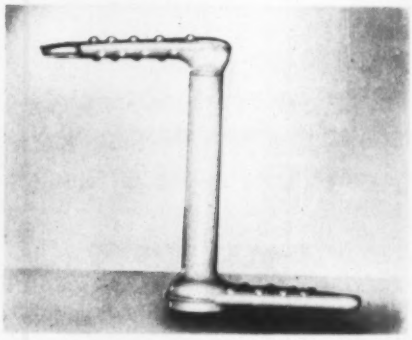
Motorola, Inc.

***TV and stereo**—Heat resistance coupled with rigidity, moldability, dimensional stability and scratch resistance were major factors in Motorola's use of polypropylene in the base for its new portable stereo (left) and the back for its new 19-in. compact TV (right). Parts are shown at top.*



Motorola, Inc.

***TV knobs**—Heat resistance was the primary reason Motorola switched from butyrate to polypropylene in TV knobs. Lower cost is an additional benefit.*



Industrial Molding Corp.

***Dishwasher parts**—Resistance to 250 F, no stress cracking in detergents, toughness and colorability were primary reasons for use of polypropylene in water distributor for automatic dishwasher produced by Waste King Corp. Parts are injection molded and welded to form complex configuration.*

Why did they choose polypropylene?

The performance advantages of polypropylene in terms of standard ASTM test results have been relatively well publicized. But very little design work in thermoplastic materials is based on specific property values reported from standard tests. Consequently, it is interesting to examine just how important polypropylene's reported merits are in actual cases where the material is being used.

Low cost the basic premise

Underlying all engineering evaluation of polypropylene is the low cost of the material. It is important to keep this in mind.

One user, for example, says: ". . . they finally have a material with not just marginal heat resistance above 212 F, but good stability at such temperatures . . ." Another: ". . . no other material we looked at had the chemical resistance that polypropylene has . . ."

These comments are not meant to imply that there is no other material with resistance to heat and chemicals equivalent to that of polypropylene. These users mean that no other *low cost, injection molding material* has equivalent resistance to heat and chemicals.

In discussing heat resistance, few end users mentioned higher cost nylon or acetal; in discussing chemical resistance, none mentioned higher cost chlorinated polyether (Penton) or the fluorocarbons.

In cases where polypropylene directly replaced another material, competitive materials evaluated before selecting polypropylene included high density polyethylene (35¢ per lb; 1.2¢ per cu in.); impact polystyrene (29¢ per lb; 1.1¢ per cu in.), cellulose acetate butyrate (62¢ per lb, 2.7¢ per cu in.), phenolics (35¢ per lb; 1.7¢ per cu in.), urea (25¢ per lb; 1.4¢ per cu in.), zinc die castings (17¢ per lb; 4¢ per cu in.), and aluminum sheet (50¢ per lb; 5¢ per cu in.).

Of course, the above figures are all materials costs. The injection molding process offers exceptionally low per-part cost if sufficient volume is warranted.

How important is heat resistance?

In *low cost* injection molding materials, only two thermoplastics are available for service at 212 F and above: high density polyethylene and polypropylene. Comparisons are unavoidable. High density polyethylene softens at 250-260 F; polypropylene at about 320 F. The question is: just how important is the increase in heat resistance available in polypropylene?

Results of the survey indicate that the heat resistance of polypropylene has been critical in its selection on two counts:

1. In the 250-300 F temperature range, polypropylene is the only *low cost* injection molding material that can provide a low-stress pseudo-structural part.

2. For structural parts operating in a controlled temperature environment in the neighborhood of 180-240 F (such as certain

The Story Behind This Report

"We are quite happy with this material, frankly," summed up the chief product engineer of a large housewares manufacturer in the Midwest.

"They have a lot to learn about polypropylene," warned another design engineer of another large housewares producer.

Behind these somewhat differing views lie three years of use of polypropylene. Acceptance of polypropylene, judging by volume of material sold, is good. And volume is expected to increase substantially in the next few years.

It was against this background that M/DE set out to learn just what end users of the material really think of it. More specifically, we wanted to find out:

1. Just how important are polypropylene's much publicized advantages?

2. What problems are being encountered in its use?

3. What is the status of technical information and service on the material—both in quality and in quantity?

Molded products, mainly

We talked briefly with people in the polypropylene textile and film business. Although polypropylene holds high promise in both these forms, and use in these forms is growing rapidly, such uses are newer than applications for injection moldings. Because of this newness, and our space limitations, this article concentrates on what users of polypropylene *molded parts* think of the material.

We made no attempt to canvass the field to reach all users of polypropylene moldings. The companies called upon, and the engineers and designers interviewed, represent a large segment of the users of the material—but by no means all. Consequently, this report must be considered a more or less random sampling of applications and opinions.

No slams intended

In a number of cases in this article, polypropylene is compared with other materials, particularly high density polyethylene. Obviously, since we started out to report what users think, the applications reported on are generally ones in which polypropylene was finally selected. The reasons given in each case for turning down the alternative materials are not intended to belittle those materials. The factors mitigating against a material in a specific case may not be generally applicable to that material. The individual decisions may well indicate valid trends, and these we have tried to point out, but in the final analysis each application is indeed unique.

chemical processing streams), the higher heat resistance of polypropylene provides an additional safety factor and can reduce the precision required in process controls.

The first case: where better heat resistance is mandatory—The back for the new Motorola TV and the base for their new stereo portable record player is now molded in polypropylene. According to N. Taylor and H. Kiuntke of Motorola's Value Analysis Dept., polypropylene was required in the TV back because the tubes, located near the back, can produce temperatures over 240 F under extreme conditions. The material also provides the desired rigidity, permits molding of intricate screen effect, and results in a decorative, attractive part.

In the stereo base an additional benefit of polypropylene is that the unit can be placed on a table without danger of scratching or marring the tabletop.

In the 1960 Plymouths, the radio speaker grille is injection molded in polypropylene. Although the basic environmental temperature range for materials in the auto industry is —40 to 175 F, temperature of the radio speaker grille can approach 240 F. This can occur particularly in grilles located on top of the dash.

The second case: as a safety factor in process controls—American Agile Corp. makes chemical processing equipment from thermoplastic materials. According to C. F. Freedman, executive vice president, in a majority of the cases where polypropylene has been selected over polyethylene for a piece of processing equipment, the reason has been the additional margin of safety it offers.

For example, in a chemical processing stream operating at about 180-200 F, a structural high density polyethylene component may operate satisfactorily, depending, of course, on the nature of the chemicals and the stress levels. But temperature may have to be precisely controlled to preclude accidental increases in temperature that may be detrimental to the polyethylene component. The same component in polypropylene can withstand higher temperatures; thus, temperature controls need not be so precise.

According to Freedman, ". . . in many cases, the nominal increase in cost of about 10¢ per lb of fabricated material can be far outweighed by reduction in control costs . . ."

Chemical stability a major factor

Comments by end users indicate two primary areas in which the chemical stability of polypropylene are critical reasons for its use:

1. Its excellent resistance to direct attack, particularly at elevated temperatures.

2. Its resistance to environmental stress cracking.

Also important is its combination of resistance to attack by, and low permeability to, certain types of chemicals and vapors.

Resistance to direct attack—A common and widely growing application, of course, is chemical tanks, piping and couplings. A typical tank lining is one used by Thomas Strip Div., Pittsburgh Steel Co. in pickling tanks for its plating lines. The pickling solutions consist of 15% sulfuric-15% hydrochloric acid or 10% sulfuric-10% nitric acid. The tanks are operated at 150 to 180 F.

For many years, according to L. J. Crinic, plant engineer, these tanks have been made of mild steel lined with acid resistant brick. In continuous operation 24 hr a day, often six and seven days a week, the mortar joints in the brick lining would fracture and

Who's Who in Polypropylene

At time of writing, there are three commercial producers of molding grades of polypropylene in this country. They are: Hercules Powder Co. (Profax), AviSun Corp., and Humble Oil and Refining Co. Humble's polymer is being marketed through Enjay Chemical Co. (Escon) and Spencer Chemical Co. (Poly-Pro).

More to come

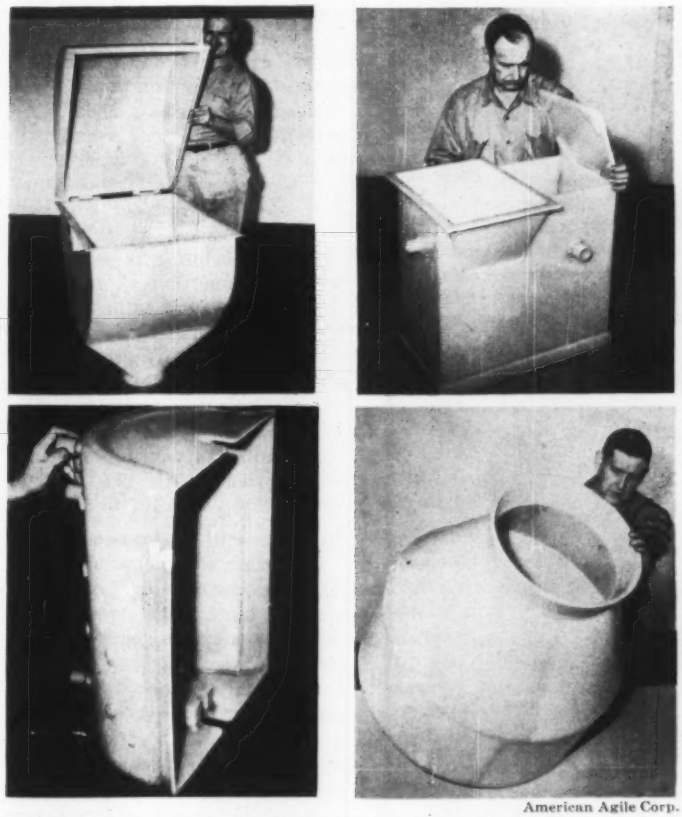
Companies that have announced commercial plants to come on stream before mid-'61 are Montecatini Co., Tennessee Eastman Co., Dow Chemical Co. and Firestone Plastics (the majority of the latter's production will probably be for internal consumption). Other companies expected to enter production are Koppers and Shell Chemical.

Many observers also look to the present producers of high density polyethylene as potential starters in the field. The plants and equipment used for the Ziegler-type low pressure process can be converted to production of polypropylene with relative ease. From a producer's standpoint it might be ideal to be able to produce both materials, controlling production to suit demand.

Hercules Powder got a good head start on competition by announcing commercial availability in December, 1957. This gave them nearly a two-year lead on the next entrant. Consequently, most molded applications are in Hercules' material. AviSun went on stream in August, 1959, followed by Humble in early 1960. Announcement of commercial availability is expected momentarily from Eastman. Estimates of volume capacity by the end of 1961 are about 265 million pounds.

Price cuts in future?

With this anticipated volume, coupled with increased production efficiency and amortization of research expenditures, the price of polypropylene should come down in the future. At present, however, the 42¢-per-lb volume price appears to be holding firm. Although only a few observers foresee so drastic a price reduction as to bring the price down to that of high density polyethylene, such a development in the future may not be unlikely.



American Agile Corp.

Variety of components—*Hopper, wash tank, steam chest and rotary drum are typical of the many fabricated parts for chemical processing equipment that make use of polypropylene's combination of heat and chemical resistance.*

Thomas Strip Div., Pittsburgh Steel Co.

Tank linings—*Resistance to various acid solutions was the primary reason for the polypropylene liners used for these pickling tanks for plating units. Liners were fabricated by American Agile Corp.*

the mild steel tank walls corrode rather rapidly.

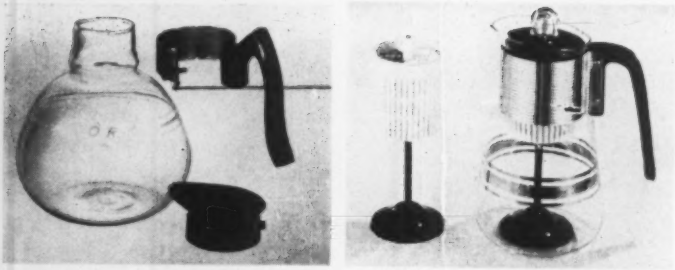
The acid brick lining was replaced with a loose polypropylene lining. The tanks have been installed for over a year and have shown no sign of deterioration.

Resistance to stress cracking—Resistance to environmental stress cracking has also been important in chemical processing equipment and other applications. However, it appears that in the majority of applications resistance to such stress cracking is simply an added benefit when the material has been selected primarily to meet other more critical needs, such as heat resistance. Probably the development of grades of high density polyethylene with excellent resistance to environmental stress cracking has somewhat minimized the importance of this property of polypropylene.

Low permeability — Resistance to chemical attack coupled with low permeability is the main reason Airkem, Inc. is using polypropylene moldings in its deodorant dispensers. Airkem, manufacturer of *air-wick*, developed a technique for producing its deodorizer in the form of a solid jelly-like cylinder—a form more practical for use than the previous liquid form. The new formulation contains, among other things, certain essential oils and emulsifiers.

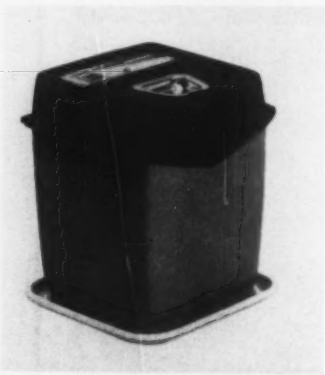
Airkem had been using stainless steel for its dispensers. To reduce costs and improve appearance, it evaluated a wide variety of plastics. Final selection boiled down to polystyrene, high density polyethylene or polypropylene.

The company's tests showed that the chemicals attacked polystyrene, seriously etching the surface; polystyrene also permitted permeation of the vapors. Polyethylene was even more permeable, though not attacked. Extensive permeability tests conducted by both Airkem and its *air-wick* distributor, Lever Bros., showed that polypropylene provided the required combination of stability and nonpermeability for the deodorant.



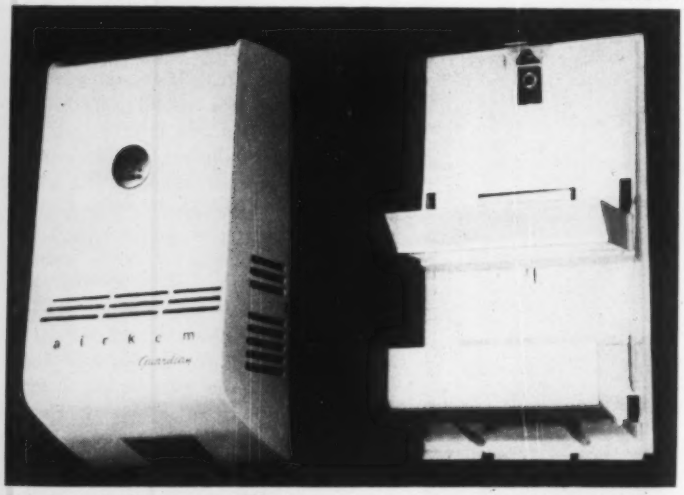
Coffee maker parts—*Both the pouring lip for Cory's commercial coffee server (left) and the basket for its home coffee brewer (right) make use of polypropylene's heat resistance, rigid resilience, toughness, and moldability.*

Squeeze mop—*The unique "hinge characteristic" plus resistance to detergents and rigidity were primary reasons for use of polypropylene in O-Cedar's squeeze mop.*



Vaporizer-humidifier—*The water container for this unit produced by Northern Electric Co. makes use of polypropylene's heat resistance, rigidity and colorability.*

Airkem, Inc.



Deodorant dispenser—*The component shown at right, designed by Monte L. Levin, is molded of polypropylene because it is not attacked by the solid deodorant which it holds. Cover at left is molded of polystyrene. Polypropylene also provides rigidity required to hold solid cylinders of deodorant in reserve, and is impermeable to the vapors emitted.*

In a self-feeding unit developed for commercial use, Airkem also found that polypropylene provided the rigidity required to hold the reserve cylinders of deodorant in place until ready for use.

General conclusions about permeability should not be drawn from this one specific case. Other end users say *their* tests—using their own chemicals or formulations—have shown that polypropylene's permeability is not much different from that of polyethylene. One major cosmetic producer says that polypropylene has shown permeability comparable with that of polyethylene for *all* its proprietary formulations. The only answer to the question of permeability appears to be to test polypropylene with the specific formulation you want to use.

No post-mold shrinkage

In certain designs where close tolerances must be held, the post-molding dimensional stability of polypropylene has been a final factor in selection.

For example, Cory Corp. found that in certain lines of its commercial all-glass coffee-servers, pouring lips were frequently broken by rough use. Cory needed a material that would not break, nor mar other surfaces. Thermosetting plastics were not only somewhat brittle, but would not provide proper expansion characteristics to accommodate expansion in the glass diameter. Consequently, according to A. Gilissen, Cory's chief product engineer, ". . . we set about looking for an impact resistant thermoplastic that would withstand high temperatures—at least to 212 F . . ."

Cory evaluated high density polyethylene. For its particular application, however, a tight seal between spout and pot was critical, requiring close tolerances on the molded spout. After various attempts, Cory engineers concluded that the post-mold shrinkage of polyethylene resulted in too much dimensional uncertainty for this use.

In shifting to polypropylene, according to Gilissen, Cory found that though impact strength was

not as great as that of high density polyethylene, it was sufficient for the type of impact to which the spouts were subjected.

Rigidity plus resilience

The combination of rigidity and resilience is often mentioned by end users as an important benefit from both the final performance and the molding and processing standpoints. Rigidity provides the final desired firmness or stability in the part; resilience permits the economical molding of undercuts, grooves and bosses with no need for costly cam mechanisms in the mold to permit part release.

In the Cory home coffee brewer the basket was originally a drawn aluminum part. With the aluminum basket, either the top of the brewer had to fit so snugly that the basket could not fall out when the coffee was poured, or the housewife had to remove the basket before pouring the coffee. In the redesign, lugs are attached to the basket to hold it inside the pot during pouring.

The polypropylene cover has three small projections molded in which engage with an annular groove in the basket. This arrangement permits the cover and the basket to be interlocked so that when the cover is removed the basket and stem are also removed. The resilience of the material permits stripping of both cover and basket from simple molds in spite of the projections and annular groove. Also, lack of cold flow permits continuous re-use without causing a permanent distortion in the projections or lugs.

This same combination of rigidity and resilience is a critical reason for the wide use of polypropylene in container closures. In addition to providing a decorative, glossy closure, according to R. L. Williams of Avon Products, Inc., polypropylene has the following benefits:

1. Resilience permits molding of relatively complex closures with reentrant angles which can be simply removed from the mold.

2. Rigidity permits use of conventional threads, whereas with high density polyethylene closures special threads usually have to be provided to preclude "overturn."

3. In some cases, polypropylene closures do not require cap liners, which can make the closure less costly than in urea thermosetting plastic.

On the other hand, at present Williams does not see any benefits to be derived from polypropylene in blown containers. Avon has eliminated environmental stress cracking problems in its blown detergent bottles by using one of of the newer types of high density polyethylene. Also, Avon says that to date it has not found polypropylene any less permeable than polyethylene to the formulations it packages.

The unique integral hinge

The unique "hinge characteristic" of polypropylene has been the reason for using the material in a number of parts. Typical of many users' reactions: "It shouldn't work—but it does."

O-Cedar, Div. of American-Marietta Co., uses this hinge principle in an addition to its line of squeeze mops. The result has been a 25% cost reduction, and a two-thirds reduction in weight of the squeeze unit on the mop. According to O-Cedar's Design Engineering Dept., its unit has been flexed with a "normal squeeze action" 50,000 times, equivalent to about 10 years of service, with no discernible ill effects.

An article describing the hinge principle in detail and a number of uses for the hinge appeared in M/DE, Oct '60, p 117.

What's wrong with polypropylene?

In discussing problems end users have encountered in polypropylene, care has been taken to concentrate only on problems arising during proper use of the material. Any material is limited by its inherent properties. Fortunately, it appears from the results of this particular survey that engineers and designers have been both careful and well-advised in their selection of polypropylene.

In approaching this survey, we continually probed for specific problems that end users may have encountered in using polypropylene. The purpose, of course, was to better define the material's present limitations. In some cases, users disagree. In some cases, materials suppliers disagree. Following are the survey findings that we believe may be pertinent or helpful to users.

What about low temperature brittleness?

No discussion of the limitations of polypropylene could be complete without mention of its much-publicized "low temperature brittleness." This deficiency is relative. At 0 F polypropylene's impact strength is comparable to that of impact styrene. Where polypropylene suffers is in comparison with polyethylene.

But what has been the experience of polypropylene users?

It appears that the majority of applications for polypropylene at present do not encounter low temeratures in service. When queried about winter shipping problems, most manufacturers of polypropylene parts mentioned no problems. In some cases, the reasons are obvious. For example, glass coffee pots with polypropylene components are packed as glassware; TV sets and radios with polypropylene components are packed as "fragile" appliances.

On the other hand, a major housewares manufacturer testing for just this characteristic did run into a problem. Polypropylene silver baskets for dish racks were molded (in molds used for polyethylene), and packed for shipment in a manner identical with that used for polyethylene baskets. They were shipped in winter in the northern section of the coun-

try. A high percentage of parts was broken.

With or without testing, it is important to be fully aware of the actual service conditions to which the part will be exposed. For example, the brittleness of a polypropylene radio speaker grille on a cold winter day is not important if, under ordinary service conditions, the grille would not be exposed to shock loading or rough handling.

A number of materials specialists in the auto industry were asked about low temperature brittleness. The consensus was that the material for each component in a car is selected, not on the basis of standard ASTM test results, but on the basis of the type of service the part must provide. Consequently, the resistance of a particular part to breakage must be evaluated by simulated service testing of the actual part in the type of environment to which it will be exposed.

Packard Electric Div. of GM, for example, has been using polypropylene for connector bodies of electrical harnesses for cars for about two years. One of the primary reasons for selecting polypropylene was its heat resistance (temperature runs about 250 F max near the motor). In evaluating the moldings for cold weather durability, Packard tested prototype parts at −25 to −30 F. Despite what standard test data on polypropylene show, the parts proved to perform satisfactorily under the type of shock loading to which the parts might be exposed in service. As one Packard engineer said, you have to "just try it, rather than predict" from standard ASTM tests.

Another example of successful use where relatively low temperatures are expected is the blow molded carafe produced by Plastic Assembled Products Co. Low temperature tests indicated that the carafe could be filled with ice and water and dropped to a concrete floor from a height of 4 ft without damage. The material used, however, was a carefully selected polypropylene blend.

OTHER PARTS . . .

Avon Products, Inc.

Closures—*Closures for cosmetics make use of polypropylene's rigidity plus resilience, colorability, toughness, compatibility, and glossy surface.*

Hercules Powder Co.

Hospital carafe—*One of the first blow molded polypropylene products, this carafe produced by Plastic Assembled Products Co. uses a special polypropylene blend. The carafe can be sterilized in steam autoclaves at 250 F, yet withstands dropping when filled with ice water.*

Decoration reported to be a problem

According to several major product manufacturers, finishing polyproplyene by such techniques as painting or hot stamping has been a problem.

One manufacturer, after limited success with hot stamping directly on the polypropylene part, now mechanically applies a cellulose acetate butyrate insert which carries the hot-stamped marking.

Another major user reports that though it does produce some polypropylene closures which are marked by hot stamping, the marking operation is a real problem. With some closure designs, hot stamping appeared to be such a tough problem that the producer has shifted from polypropylene to urea.

There is apparently some disagreement over the ease of hot stamping polypropylene. One large custom molder reports he has been highly successful in hot stamping polypropylene. He adds, as pointers, that:

1. It is much easier to hot stamp raised lettering than indented lettering.

2. The stamping tape should have a polyester (polyethylene terephthalate type) backing to withstand the higher temperatures used in stamping polypropylene.

One materials supplier says ". . . we definitely have a problem there . . ." He draws attention to an important distinction between moldings and film. There is little difficulty in marking polypropylene film because it is easy to install equipment to slightly oxidize the surface on a continuous basis, making it receptive to inks. On molded parts, however, such pretreatment is costly. The higher temperatures needed for hot stamping polypropylene in comparison with polyethylene add to the difficulties.

Another supplier, on the other hand, says "polypropylene hot stamps beautifully." Whichever view is more correct, end users feel that a problem does exist. If hot stamping difficulties have been solved by materials suppliers, then the problem lies in the fact that this solution has not been completely detailed to the users.

Surface can be a problem

An important reason for the use of polypropylene in many parts has been the glossy, decorative surface that can be produced. Some users say, however, they have had problems in producing a smooth, high gloss surface on a relatively large, complex molding. The difficulties apparently arise when the "back" of the part has a number of bosses, ribs, or other thicker sections molded in. These can result in sink marks and other distortions to detract from the glossy reflective surface.

The problems in obtaining proper surfaces on large area parts are mainly due to high shrinkage. They appear most troublesome when polypropylene is compared with a low shrinkage, inherently glossy material such as polystyrene. There are bound to be more problems in molding no-sink-mark parts out of polypropylene with an 0.015-0.030-in. per in. mold shrinkage, than in polystyrene with its 0.002-0.008-in. per in. shrinkage.

Is enough technical information available?

To an engineer considering the use of any relatively new material a critical question is: Can my suppliers tell me enough about the material so that I can use it effectively, with a minimum of redesign and trial and error?

In this survey, we tried to find out how end users feel about:

1. The status of molding and processing technology in polypropylene. That is, does polypropylene offer many molding and processing problems that affect the final customer for a molded part.

2. The amount of knowledge that materials suppliers, and their technical service people, have about polypropylene. Do materials suppliers provide enough reliable performance and processing information so that the user can design realistically with polypropylene?

3. Materials availability. Do end-users have to use a single source, or can they specify a single source "or equivalent" with some reliance on the ability of several materials suppliers to meet their specifications for "equivalence"?

Molding, converting technology reasonably well developed

The consensus among users is that at present there are no real problems in getting good delivery of reproducible, high quality moldings in polypropylene. Several report that this was not the case a year or so ago. Polypropylene has its own processing characteristics, and there was some difficulty in finding molders familiar with it. There was also apparently some reluctance on the part of molders unfamiliar with polypropylene to "get involved with it."

However, at present there appear to be enough knowledgeable molders to eliminate this problem.

This does not mean that there are no problems in molding polypropylene, as the earlier discussion should make clear. It merely means that if you decided to specify polypropylene for a molded part, you could readily find a molder who could make the part to your specifications.

In this regard there appear to be more problems in other forms. One user is interested in using extruded or vacuum formed polypropylene for packaging his product. He investigated possibilities about a year ago, but was unsuccessful in finding a supplier.

According to current reports, extrusion of tubing is quite readily accomplished. However, it is hard to obtain a good surface consistently in large diameters or large profiles. The main reasons appear to be the high extrusion temperatures and the relatively high shrinkage of the material.

In vacuum forming, or thermoforming, of polypropylene sheet, little appears to have been done. The relatively narrow processing temperature range of polypropylene has caused problems in sag and formability.

Some disagreement on quality, quantity of data available

In the development of any new material, basic design and processing information takes time to develop. Many end-users queried feel that both performance and processing data now available from materials suppliers is adequate for initial evaluation of the material. One large appliance producer, when asked if quality and quantity of such information was sufficient at present for his purposes, replied: ". . . I would say so, but it wasn't a year ago . . . nobody had it. We made an attempt to use polypropylene about two years ago . . . but there were no data."

A number of end-users commented that the polypropylene producers "still have a lot to learn"—a statement that most of the producers would agree with. One large user, equipped with his own molding shop and faced with a particularly tricky design in polypropylene, feels that there is much to be learned yet about the molding and extrusion characteristics of the material. But most comments on the shortcomings of available information referred to data that usually take a long time to generate, such as aging effects.

The high crystallinity of polypropylene has apparently created a need for new data. One engineer, pointing out that he had not had to cope with a material of such high crystallinity in the past, said he needed better correlations of crystallinity and performance, and more basic information on 1) effects of aging on crystallinity and performance, and 2) possibly most important of all, effects of molding conditions on both initial crystallinity and crystallinity after aging.

Other types of specific data on polypropylene that users say they need are:

1. More meaningful information on scratch and abrasion resistance.

2. Better information on effects of orientation.

3. Data on dust and dirt attraction and ways to avoid it.

Materials supply: equivalence a problem

At present, getting polypropylene does not appear to be a problem. In fact, judging from the number of announced (and potential, though unannounced) entries into polypropylene production, plus the capacity of present producers, some observers are concerned about overproduction.

From the end-user's standpoint, a "buyer's market" has its advantages. In the long run, however, oversupply of polypropylene could hurt the user. Oversupply could result in competition based strictly on price, which could be attended by a decrease in quality of both material and processing. Also, a smaller margin for the materials supplier could result in curtailment of research and development in improving present grades and adding new grades of polypropylene.

Oversupply is definitely not a problem at present, but difficulty in establishing "equivalence" is.

Virtually all polypropylene is now specified by materials supplier's trademark "or equivalent." According to most end-users, supposedly comparable grades of material from different suppliers process and perform quite differently. To some this presents a problem in establishing an alternate source of supply. To companies who prefer to deal with only one source, of course, it is unimportant.

Other end-users feel it is primarily a problem for their molders or fabricators. Such engineers feel that they have selected and specified a type and grade satisfactory for their particular needs. If the molder or converter wants to establish the "equivalence" of another supplier's material, that is up to him.

Acknowledgments

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Eastman Chemical Products, Inc.
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Hercules Powder Co.
Motorola, Inc.
Northern Electric Co.
O-Cedar, Div. of American-Marietta Co.
Packard Electric Div., General Motors Corp.
Parke, Davis & Co.
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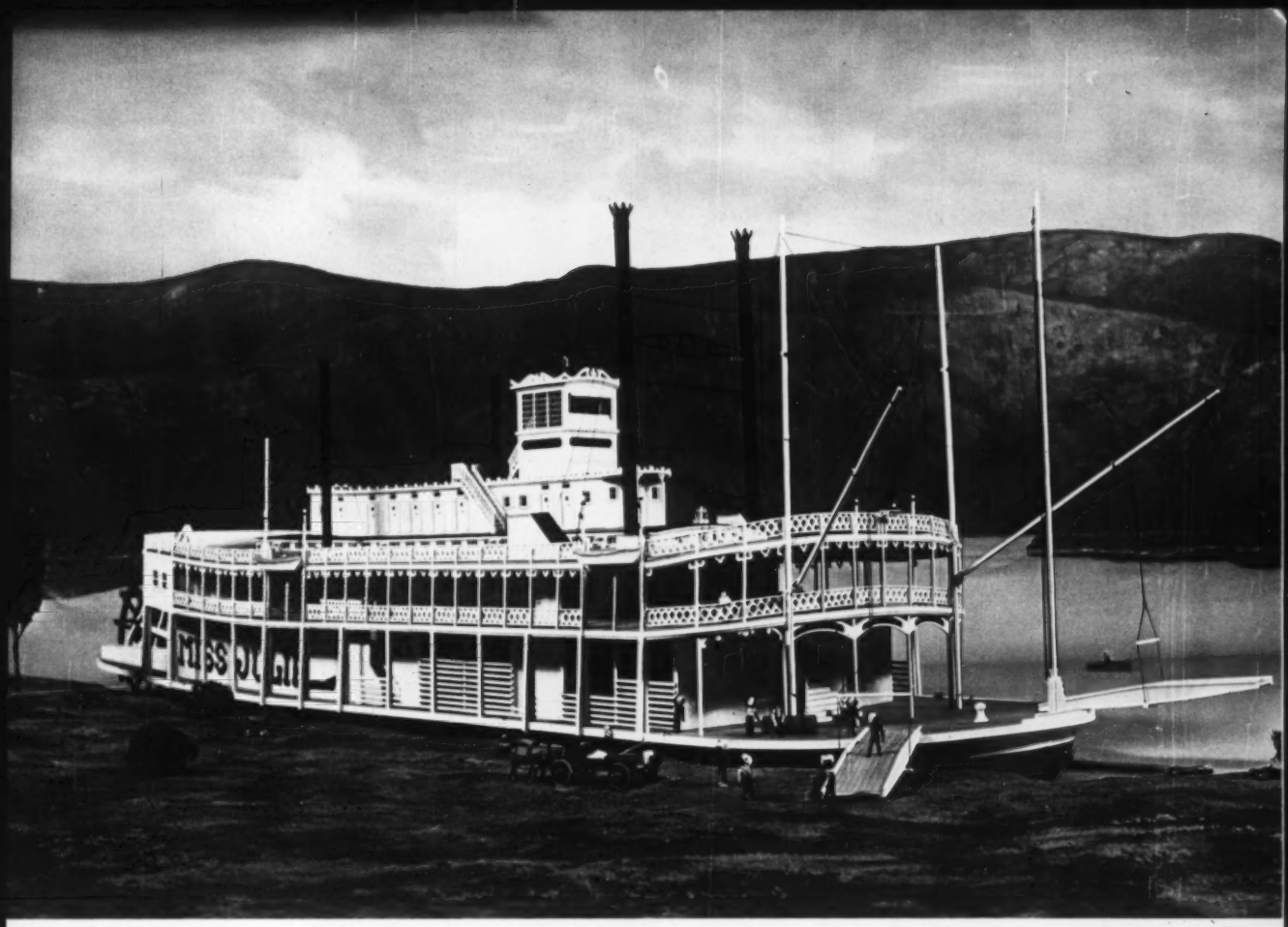

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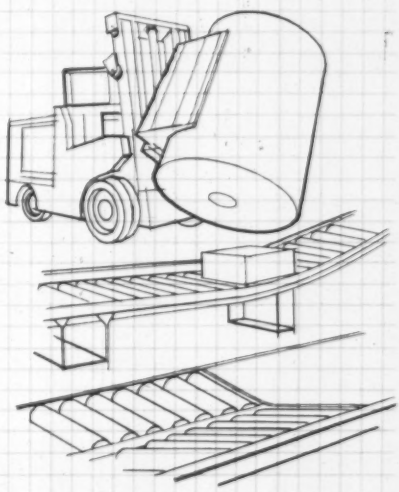

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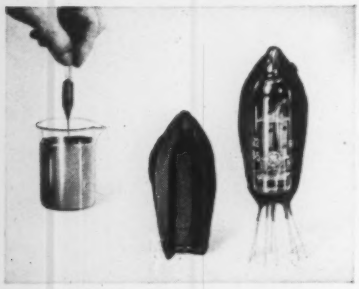
CANADA: Railway & Power Engr. Corp., Ltd. **EXPORT:** Copperweld Steel International Company, 225 Broadway, New York 7, New York

General Electric Silicone Rubber finds dozens of uses in missile systems. How many more will prove vital?

General Electric silicone rubber has the "thermal toughness" to stand up under the searing heat of rocket blast-off or possible atomic attack. Add very good electrical properties and excellent resistance to aging, weathering, moisture, flame, ozone and corona and you can easily see why silicone rubber is now being used in virtually every U.S. missile and space vehicle.

Since both space technology and silicone rubber are relatively new, General Electric believes there are many more areas not yet explored where silicone rubbers can help keep a missile functionally reliable and combat-ready. To help designers in their evaluation work, we list here the principal properties and applications of G-E silicone rubber.



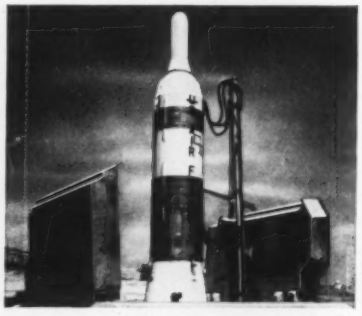
RTV LIQUID SILICONE RUBBER — One of the most versatile materials developed in recent years, RTV is a liquid rubber that cures at room temperatures. Like all silicone rubber, it remains flexible over a wide temperature range and is virtually ageless. Since it comes in a wide range of viscosities, it can be poured, sprayed, dipped, painted or applied with a pressure gun or spatula. It bonds tightly to metal when a primer is used. When not primed, you can readily remove RTV and then reapply more. You can impregnate tightly wound coils with RTV or form sections several inches thick.

You can control cure time from two minutes to 24 hours. These are RTV's typical properties:

Viscosity	from 120 poises (very pourable) to 12,000 poises (paste)
Specific Gravity	1.2 to 1.5
Solids Content	100%
Shrinkage	0.2%
Heat Resistance	from —90°F to 600°F, and as thermal insulation, in 5500°F flame for minutes
Ozone Resistance	Comparable to Mica
Electrical Properties	See last table

Applications—RTV is used as a high temperature structural sealant in missiles, satellites and space vehicles. It is used to pot and encapsulate electronic components and assemblies for electrical and heat insulation and for protecting delicate components from physical damage. It is commonly used as an impregnating insulation in transformer coils, to pot and hold cable in raceways and to pot cable breakouts. You can make flexible molds with RTV and hence make accurate, duplicate castings from originals.

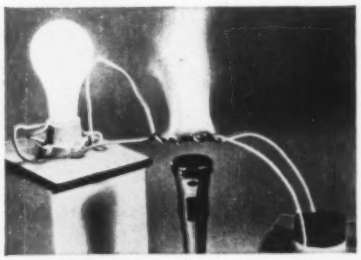
RTV is an excellent thermal barrier and as such is applied on and around missile nozzles. Tests show RTV's resistance to flame temperatures as high as 5500°F for several minutes. RTV also functions as a flexible ablative material and is used around probe holes, along raceways, and between stages and structural joints on the missile skin.



HEAT CURED SILICONE RUBBER PARTS —Silicone rubber gaskets, port seals, O-rings, shock mounts and other mechanical parts are not only used on missiles but have wide application in ground support equipment. For instance, missile silo doors use silicone rubber seals that will stand up to outside weathering, ozone and abuse for years and which will also resist the heat of missile launching and nuclear attack. Silicone rubber also resists brief exposure to cryogenic materials.

Silicone rubber has long-lasting temperature resistance from —150°F to 600°F, with excellent electrical, weathering, ozone, corona, radiation and nonaging properties at these temperatures. High tensile strength and low compression set are also within its range of desirable properties:

Tensile Strength, psi	800—1500
Elongation, %	100—600
Hardness Durometer (Shore A)	25—80
Compression Set, %	10—80
Tear Resistance lb/in	40—200
Radiation Resistance	1×10^8 roentgens
Electrical Properties	See table below



WIRE AND CABLE INSULATION — The long term reliability of silicone rubber when operating in high ambient temperatures and when current over-loads cause the conductor to approach 500°F is an important feature of silicone insulation. In an 1800°F flame, specially constructed silicone rubber insulated cables will continue to insulate for hours, forming a non-conductive ash that gives off no toxic fumes. And short term reliability is obtained even when silicone rubber is exposed momentarily to a direct flame of 5500°F.

Because of this excellent heat resistance, more current can be carried than in conventional cable (or smaller cable can be used). Other features: best compression set of all elastomers at temperature extremes, so that silicone rubber wire and cable does not deform under clamps; high ozone, corona, radiation and weather resistance, low moisture absorption, flexibility down to —100°C. These are the typical properties:

Volume Resistivity	10^{15}—10^{16}
Dielectric Strength, volts/mil	600—650
Dielectric Constant, 60 cps	3.0
Power Factor	.0010—.0050
Radiation Resistance	1×10^8 roentgens
Physical properties	Similar to table above.

Applications—Wiring harness made of silicone rubber insulation is often found throughout missiles. Cable offers added reliability for use in various places throughout the launch complex below ground from power plant to silos. All combat vessels built for the U.S. Navy during the last ten years, including fleet ballistic missile submarines and the new nuclear-powered cruiser and aircraft carrier, have silicone rubber insulated cable installations in all fixed wireways. In every case, silicone rubber is chosen because it is virtually non-aging, stands up to intense heat better than any other flexible insulating material, and continues to operate even when subjected to fire.

●

There are many more places where G-E silicone rubbers' inherent properties can be vital in missiles, satellites and space vehicles. For further data, call your nearest G-E sales office or write Section B1233. **Silicone Products Department, General Electric Company, Waterford, New York.**

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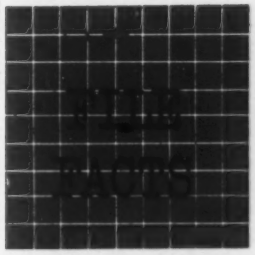
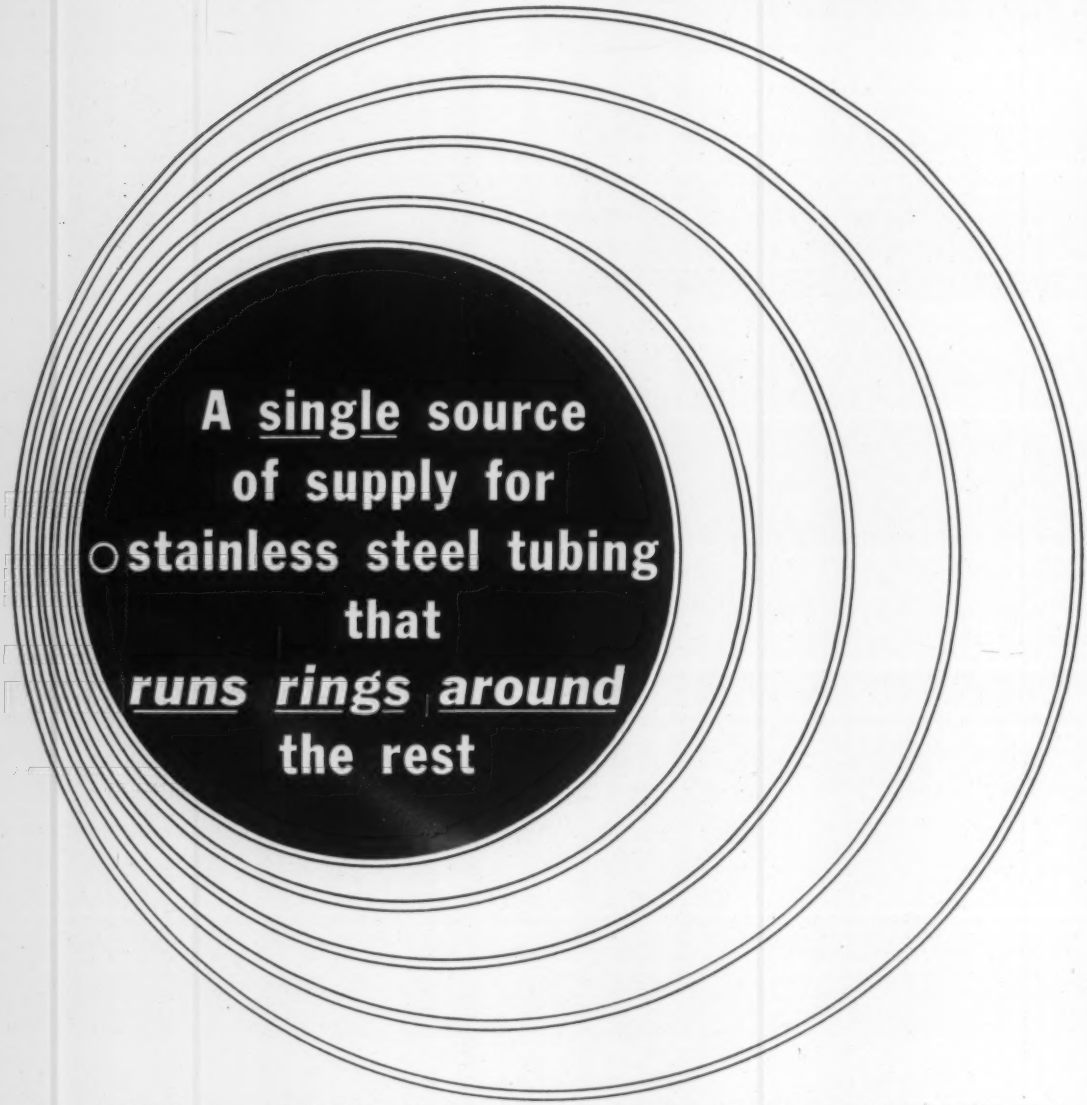


Corrosion Ratings of Copper and Copper Alloys[a]

Medium	Copper		Low-Zinc Brass		High-Zinc Brass			Special Brass		Phosphor Bronze		Alum-inum Bronze[b]	Copper-Silicon[c]	Cupro-Nickel		Nickel Silver (18%)
	Electro-lytic Tough Pitch	Phos-phor-ized	Com-mercial Bronze	Red Brass	Car-tridge Brass	Archi-tectural Bronze	Muntz Metal	Tobin Bronze	Arsen-ical Admir-alty	A	D			10%	30%	
Acetic Acid	B	B	B	B	D	D	D	D	C	B	B	B	B	B	B	B
Acetic Anhydride	B	B	B	B	D	D	D	D	C	B	B	B	B	B	B	B
Acetone	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Alcohols	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Alum	B	B	B	B	D	D	D	D	B	B	B	B	B	B	A	B
Alumina	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum Chloride	B	B	B	B	D	D	D	D	C	B	B	B	B	B	A	B
Aluminum Hydroxide	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum Sulfate	B	B	B	B	D	D	D	D	B	B	B	B	B	B	A	B
Ammonia, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ammonia, Moist	D	D	D	D	D	D	D	D	D	D	D	D	D	D	C	D
Aniline	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Aniline Dyes	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Asphalt	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Atmosphere, Industrial	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Atmosphere, Marine	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Atmosphere, Rural	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Beet Sugar Syrups	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Benzine	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Benzoic Acid	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Benzol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Bleaching Powder, Wet	B	B	B	B	D	D	D	D	B	B	B	B	B	B	B	B
Borax	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Boric Acid	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Brines	B	B	B	B	D	D	D	C	B	B	A	B	B	A	A	A
Bromine, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Bromine, Moist	B	B	B	B	D	D	D	D	C	B	B	B	B	B	B	B
Butane	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Butyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Calcium Chloride	B	B	B	B	D	D	D	C	B	B	A	B	B	A	A	A
Calcium Hydroxide	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Calcium Hypochlorite	B	B	B	B	D	D	D	D	B	B	B	B	B	B	B	B
Cane Sugar Syrups	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Carbolic Acid	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Carbon Dioxide, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Carbon Dioxide, Moist	B	B	B	B	C	C	C	C	B	B	B	B	B	B	B	B
Carbonated Water	B	B	B	B	C	C	C	C	B	B	B	B	B	B	B	B
Carbon Disulfide	B	B	B	B	A	A	A	A	A	B	B	B	B	B	B	B
Castor Oil	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Chlorine, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Chlorine, Moist	C	C	C	C	D	D	D	D	C	C	C	C	C	C	B	C
Chloroform, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Chromic Acid	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Copper Nitrate	C	C	C	C	D	D	D	D	C	C	C	C	C	C	C	C
Copper Sulfate	B	B	B	B	D	D	D	D	B	B	A	B	B	B	B	B
Cresote	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Crude Oil	B	B	B	B	C	C	C	C	B	B	B	B	B	A	A	B
Ethers	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethyl Acetate	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Ethyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethyl Chloride	B	B	B	B	C	C	C	C	B	B	B	B	B	B	B	B
Ethylene Glycol	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Ferric Chloride	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Ferric Sulfate	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Ferrous Chloride	B	B	B	B	D	D	D	D	B	B	B	B	B	B	B	B
Ferrous Sulfate	B	B	B	B	D	D	D	D	B	B	B	B	B	B	B	B
Formaldehyde	A	A	A	A	C	C	C	C	A	A	A	A	A	A	A	A
Formic Acid	B	B	B	B	D	D	D	D	C	B	B	B	B	B	B	B
Freon	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Fuel Oil	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Furfural	A	A	A	A	C	C	C	C	A	A	A	A	A	A	A	A
Gasoline	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glue	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Glycerine	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

[a]See p 131.

continued on p 131



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Corrosion Ratings of Copper and Copper Alloys[a]

(continued from p 129)

Medium ↓	Copper		Low-Zinc Brass		High-Zinc Brass			Special Brass		Phosphor Bronze		Alum-inum Bronze[b]	Copper-Silicon[c]	Cupro-Nickel		Nickel Silver (18%)
	Electro-lytic Tough Pitch	Phos-phor-ized	Com-mercial Bronze	Red Brass	Car-tridge Brass	Archi-tectural Bronze	Muntz Metal	Tobin Bronze	Arsen-ical Admir-alty	A	D			10%	30%	
Hydrocarbons, Pure	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Hydrogen	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Hydrogen Peroxide	B	B	B	B	C	C	C	C	B	B	B	B	B	B	B	B
Hydrogen Sulfide, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Hydrogen Sulfide, Moist	D	D	D	D	C	C	C	C	C	D	D	D	D	D	C	C
Kerosene	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Lacquers	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Lacquer Solvents	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Lime	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Linseed Oil	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Magnesium Chloride	B	B	B	B	D	D	D	D	C	B	B	B	B	B	B	B
Magnesium Hydroxide	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Magnesium Sulfate	A	A	A	A	C	C	C	C	A	A	A	A	A	A	A	A
Mercury	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Mercury Salts	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Methyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Methyl Chloride, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Mine Water	C	C	C	C	D	D	D	D	C	C	C	C	C	C	C	C
Natural Gas	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Nitric Acid	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Nitrogen	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Oleic Acid	B	B	B	B	C	C	C	C	B	B	B	B	B	B	B	B
Oxalic Acid	B	B	B	B	D	D	D	D	C	B	B	B	B	B	B	B
Oxygen	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Paraffin	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Phosphoric Acid	B	B	B	B	D	D	D	D	C	B	B	B	B	B	B	B
Potassium Chloride	B	B	B	B	D	D	D	C	B	B	A	B	B	A	A	A
Potassium Cyanide	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Potassium Hydroxide	B	B	B	B	C	C	C	C	B	B	B	B	B	A	A	A
Potassium Sulfate	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Propane	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Rosin	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sea Water	B	B	B	B	C	C	C	B	A	B	A	A	B	A	A	A
Sewage	A	A	A	A	C	C	C	B	A	A	A	A	A	A	A	A
Silver Salts	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Soap Solutions	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Sodium Bicarbonate	B	B	B	B	C	C	C	C	B	B	B	B	B	A	A	A
Sodium Carbonate	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Sodium Chloride	B	B	B	B	D	D	D	C	B	B	A	B	B	A	A	A
Steam	A	A	A	A	C	C	C	A	A	A	A	A	B	A	A	A
Stearic Acid	B	B	B	B	C	C	C	C	B	B	B	B	B	B	B	B
Sugar Solutions	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Sulfur, Dry	B	B	B	B	A	A	A	A	A	B	B	B	B	B	A	B
Sulfur, Molten	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Sulfur Dioxide, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sulfur Dioxide, Moist	B	B	B	B	D	D	D	D	B	B	B	B	B	C	C	C
Sulfurous Acid	B	B	B	B	D	D	D	D	B	B	B	B	B	C	C	C
Tannic Acid	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Tar	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Toluene	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Trichlorethylene, Dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Trichlorethylene, Moist	B	B	B	B	C	C	C	C	B	B	B	B	B	B	A	B
Turpentine	A	A	A	A	B	B	B	B	A	A	A	A	A	A	A	A
Varnish	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Water, Potable	A	A	A	A	C	C	C	C	A	A	A	A	A	A	A	A
Zinc Chloride	C	C	C	C	D	D	D	D	C	C	C	C	C	C	C	C
Zinc Sulfate	B	B	B	B	D	D	D	D	B	B	B	B	B	B	B	B

[a]These data are based on consideration of laboratory test data, service experience and a general knowledge of corrosion resistance properties. It must be fully recognized that the ratings are relative only, and definite unqualified recommendations of corrosion resistance cannot be made. Corrosion resistance or rate of corrosion is greatly affected by conditions of exposure, such as presence of oxidizing agents, movement of solution, aeration, temperature and similar factors.

Key: A—Should be suitable under most conditions.
B—Offers good corrosion resistance. May be considered in place of metal with an "A" rating when some property other than corrosion resistance governs its use.
C—Fair corrosion resistance.
D—Not suitable.

[b]95 Cu–5 Al. [c]95.8 Cu–3.1 Si–1.1 Mn.

Source: American Brass Co.

Beauty treatment for BOEING 707

. . . MUTUAL CHROMIUM CHEMICALS

Sleek, fast and high flying . . . she's a beauty, this Boeing 707 jet airliner. To help her look her best, Boeing gives the aluminum skin an anodizing treatment with Mutual® Chromium Chemicals for improved appearance and corrosion resistance.

This is just one of the many ways versatile Solvay® Mutual Chromium Chemicals serve applications ranging from metal treatment to fireworks. To fill your needs for any of the Mutual Chromium Chemicals, look to Solvay as Boeing does. Solvay is the world's largest chromium chemical producer with over 100 years' experience in their development and production.

Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

MUTUAL chromium chemicals are available through distributors and SOLVAY branch offices located in major centers from coast to coast.

For a full description of the Mutual line of chromium chemicals . . . uses, properties and comprehensive technical data . . . mail the coupon for your free copy of Solvay's new 80-page Technical Bulletin, "Chromium Chemicals."

MUTUAL CHROMIUM CHEMICALS
Sodium Bichromate • Sodium Chromate • Chromic Acid • Potassium Bichromate
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SOLVAY PROCESS DIVISION 42-120
Allied Chemical Corporation
61 Broadway, New York 6, N. Y.

Please send—without obligation—Solvay's new 80-page Technical Bulletin No. 52, "Chromium Chemicals."

Name_____ Position_____

Company_____

Address_____

City_____ Zone____ State_____

For more information, turn to Reader Service card, circle No. 321

MATERIALS AT WORK

...AT A GLANCE

Reinforced plastic floats for marina walkways, resist water, rust, corrosion, marine parasites and growths, spalling, and attack by gasoline and oil. Half-pontoons are made by spraying resin-coated glass fibers onto a form, partially curing, and then molding. Float halves are joined with epoxy cements and caulked. Because wall thickness is only 0.178 in., the floats are buoyant and easily moved. Valve fittings permit flooding and emptying to assist installation.

Source: Floats by Zenith Plastics Co., 1600 W. 135th St., Gardena Calif.; plastic resin by Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Tuning forks have replaced balance wheels and hairsprings in new transistorized wrist watches. The fork, made of a self-compensating steel (Ni-Span C), is kept vibrating at 360 cps by a transistorized control circuit which drives small electromagnetic coils on each tip. The vibrations are then converted to rotary motions which are transmitted to the hands.

Source: Bulova Watch Co., 75-20 Astoria Blvd., Jackson Heights, N. Y.

High impact vinyl copolymer sheets have replaced metal side panels for flat bed trailer trucks. They are said to be superior to metal because rusting and repainting are eliminated. The corrugated, interlocking panels resist denting, breaking, scuffing and tearing. Because the plastic is nontoxic and easily washed, the truck is said to be acceptable for hauling food.

Source: Seiberling Rubber Co., Akron 9, Ohio; panels used by Yellow Transit Lines, Detroit.

Rapid-response thermocouples made of very fine clad wire are said to measure temperatures from —330 to 2370 F. The wire, available in 650-ft lengths, has o.d.'s as small as 0.013 in. The Chromel and Alumel elements, clad in Inconel or 304 stainless steel, are insulated by highly compressed magnesium oxide powder. The thermocouples are claimed to be very rugged, and their fine dimensions suit them for rapid measurements in high velocity fluids and high neutron fluxes. Nuclear radiation is said to have no practical effect on accuracy.

Source: Amperex Electronics Corp., Hicksville, N. Y.

Light weight plus excellent corrosion resistance is the reason given for the selection of aluminum for coal mining cars. The new cars, said to be the first of their kind, use aluminum for all parts except wheels, axles and couplers. They weigh 4900 lb, as compared to 9950 lb for comparable steel cars, and are said to carry seven times their weight. In addition, the aluminum cars are expected to have a service life of 20 years—about 5 to 10 years longer than the average steel car.

Source: Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh; cars built by Irwin-Sensenich Corp., Irwin, Pa.

One of the first uses of acetal resin in autos is a tiny pump for windshield washers. The part, a gear-type, vacuum-actuated unit driven by the fan belt, is presently being used in Fords and Mercurys. Reasons given for the selection of acetal: it is lighter than the metal part it replaced; it is tough, strong, and dimensionally stable; and it is resistant to corrosive chemicals. In addition, it is easily and inexpensively injection molded.

Source: E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.; pump by Delman Co., Cookeville, Tenn.

Turn page for more "Materials at Work" →

LINDE 99.9% Pure ALUMINA ABRASIVES

BULOVA WATCH PINIONS (sample shown magnified 100x) now have important surfaces polished to a high precision finish with LINDE alumina abrasives. Actual size is at right →

Permit Critical Finishing of ALL Modern Metals with ONE BASIC MATERIAL

No longer need the minuteness of a metal part, or its shape, or its type of metal interfere with the quality of its finish.

All-new LINDE abrasive powders—of 99.9% pure alumina—now permit precision finishing and polishing, as well as sharpening and honing of many metal parts—with *one basic material.*

Depending upon usage, LINDE alumina powders can be used dry, mixed with water or other vehicles to make a thin slurry or heavy paste, or compounded with waxes in convenient stick form. They are uniform in size, thus eliminating levigation in finishing operations. And they are resistant to common acids.

Only two grades of these low-cost, fast-cutting, high-purity white powders are required: LINDE A (*alpha alumina*) for quicker cutting and an unsmeared finish; LINDE B (*gamma alumina*) for somewhat slower cutting but an extremely fine finish.

For details on alumina abrasives as applied to your production problems, write Dept. MI-12, Linde Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, New York. *In Canada:* Linde Company, Division of Union Carbide Canada Limited, Toronto 7.

PHYSICAL PROPERTIES

	Type A-5175	Type B-5125
Chemical Formula	Al_2O_3(Alpha)	Al_2O_3(Gamma)
Crystal System	Hexagonal	Cubic
Hardness, Mohs'	9	8
Particle Size approximate (microns)	0.3*	<0.1
Apparent Density (g/c.c.)	0.3-0.6	0.2-0.5
Melting Point	2050° C.	Transforms to Alpha form at high temperatures

*Type C-5250 also available in 1.0 microns (approximate) particle size.

SUGGESTED USES

CHEMICAL: Catalyst Carrier • **ELECTRONICS:** Semiconductor Polishing • **JEWELRY:** Gem Stone and Crystal Polishing; Silver Polishing • **LIGHTING:** Phosphor Preparation • **CERAMICS:** Pure Oxide Ceramics • **METAL FABRICATION:** Finishing of Metal Parts; Knife Sharpening; Microtome Knife Sharpening; Razor Blade Sharpening • **METALLURGY:** Metallographic Polishing • **OPTICAL:** Glass Polishing

LINDE COMPANY
DIVISION OF UNION CARBIDE CORPORATION

UNION CARBIDE

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For more information, turn to Reader Service card, circle No. 463

MATERIALS AT WORK

Forged Aluminum Bracket Solves Aerodynamic Problem

Use of an "impossible" aluminum forging in the Navy A3D Skywarrior's in-flight fueling system significantly increased the strength, streamlining and safety of the external assembly.

Bracket supports fuel probe

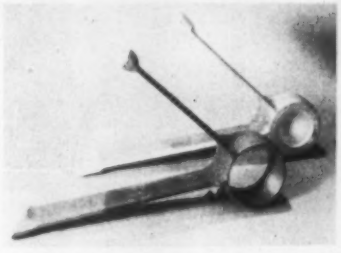
The part is the exterior support for the long thin refueling probe which enters the tanker aircraft's drogue during fuel transfer. (The probe itself posed an interesting design problem that was discussed in M/DE, Sept '60, p 181.*) The bracket was designed by Douglas Aircraft Co. engineers as a collar with two unequal legs. One leg is 16 in. long and the other is 12 in., and their thickest cross section is 3 in. by ⅝ in. Each leg ends in a large metal foot which is machined for attachment to the A3D fuselage.

While thinness is required to minimize aerodynamic drag and weight, the bracket must be strong enough to cantilever more than half of the 14-ft probe during the shock of drogue engagement, arrested carrier landings and catapult launchings, and under ordinary flight loads.

Forging properties desired

Machining, casting and welding were rejected as fabrication methods in favor of forging. Strength would be gained through controlled grain direction, and a forged bracket could be thinner and lighter. However, a forging with such thin cross sections between the accumulated metal on the leg ends and the large central mass presented a serious problem. In addition, running the parting planes up the middle of the sections instead of along the edges was an unfamiliar technique. The demand for close tolerances and excellent die match further compounded the problem.

Three forging vendors said the part could not be forged; that the metal could not be driven into the long thin edges of legs that had a 1/32-in. bottom radius. Only one vendor, Aluminum Co. of America, thought the forging could be made, but it expected short die life caused by cracks generated by metal flow into the deep cavities. A few dimensional changes were made and 2014-T42 was the metal chosen. Alloys 7075-T6 and 6061-T6 were considered and rejected—the first because the shape was considered too severe and the second because of its inadequate strength and elongation after heat treatment.



Aluminum bracket *for aircraft fueling probe machined from forging.*

Bracket withstands overloading

The first forging had a slight mismatch of 1/64 in. in one place and a bit of flashing; otherwise it was good. Subsequently 300 parts were forged perfectly and all from the original set of dies.

In static tests the forgings took 150% of load without permanent set. When the load was increased to 250% the bolt heads holding the bracket parted and the test was discontinued.

* The probe and bracket design was an entry in M/DE's 4th Annual Design Competition.

Resin-Glass Subfloor Damps Room Vibration

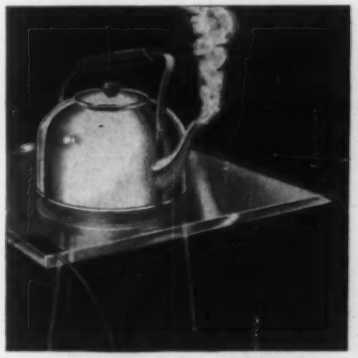
Flat sheets of fibrous glass bonded with phenolic resin are being used to isolate a factory room from external vibrations.

At the Pall Corp. plant in Glen Cove, N. Y., the only available space for expanding the telephone switching facilities was directly above a rolling mill and large shear whose vibrations would seriously affect op-

LOF GLASS

Notes on
VACUUM-DEPOSITED COATINGS

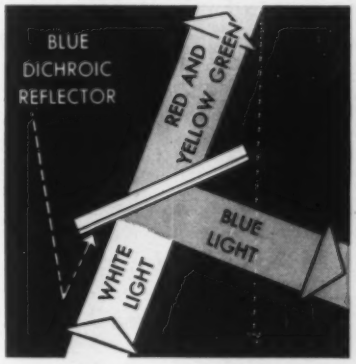
Transparent coating makes a heating unit of a piece of glass



Among vacuum-deposited coatings by Liberty Mirror is a transparent electric conductor that acts as a resistance heating element on glass.

The coating is used to defog or de-ice optical surfaces and instrument faces, camera windows, prisms, lenses and other optical elements.

Coatings put light and heat to work on new product design

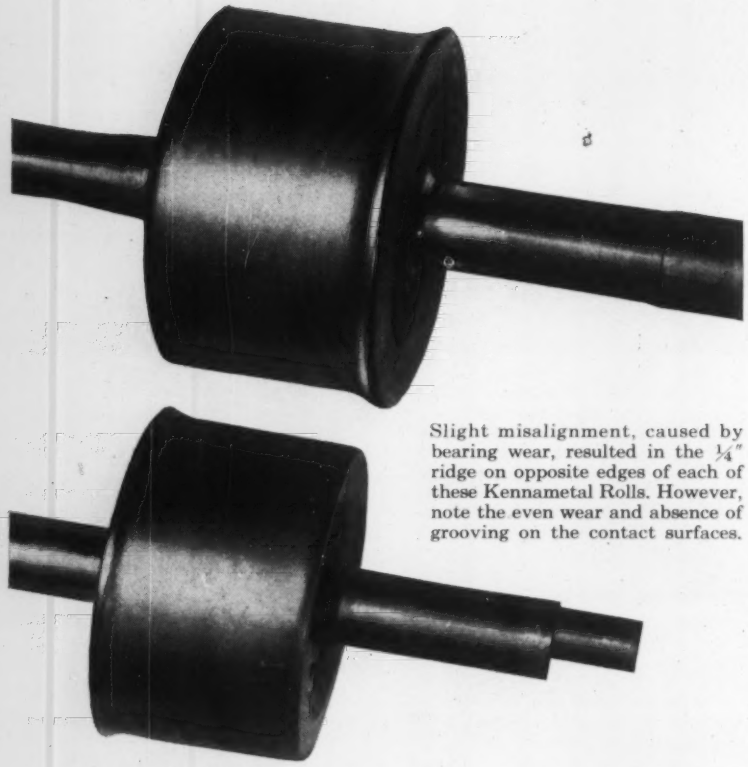


Another valuable contribution by vacuum-deposited coatings is to make aluminum or gold first-surface mirrors, neutral filters, transparent mirrors, high-efficiency beam splitters, beam-splitting dichroic mirrors and filters.

Applied to glass, metal or plastic, vacuum-deposited coatings are used in such varied products as toys, pin setters, wheel-aligning equipment, aircraft and missiles.

A reference file is available on characteristics and durability of each coating. Liberty Mirror engineers will help you solve application problems. Write Liberty Mirror Div., Libbey-Owens-Ford Glass Co., 811 Madison Avenue, Toledo 1, Ohio.

For more information, circle No. 390



Slight misalignment, caused by bearing wear, resulted in the ¼" ridge on opposite edges of each of these Kennametal Rolls. However, note the even wear and absence of grooving on the contact surfaces.

KENNAMETAL* CRUSHER ROLLS OUTLAST STEEL 72 TO 1

Working two shifts daily for 72 weeks, these Kennametal Crusher Rolls processed over a million pounds of highly abrasive aluminum oxide and ferro tungsten. Then they were removed, reground and put back into service. In the same operation, steel crusher rolls became grooved after only one week, and had to be removed.

In another application, extremely abrasive aluminum nickel alloy—used in permanent magnets—was successfully reduced by Kennametal tungsten carbide rolls to —100 mesh with no contamination. *High iron contamination encountered with previously used steel crusher rolls was eliminated.*

Kennametal has a YME up to 94 million psi . . . 3 times that of hardest steel. Chances are this extreme hardness, plus great resistance to abrasion and deformation can save *you* money through increased roll life and the virtual elimination of contamination.

Find out how Kennametal is used for other applications where contamination and severe wear are problems. Write for Booklet B-666, "Proven Uses" (more than 80 applications of Kennametal), KENNAMETAL INC., Dept MDE, Latrobe, Pennsylvania. 33550

*Trademark

INDUSTRY AND KENNAMETAL ...Partners in Progress

For more information, turn to Reader Service card, circle No. 385

eration of the telephone equipment.

The installation procedure worked out by Fibrous Glass Products, Inc. consisted of spreading asphalt tile cement over the existing flooring, laying 1-in. thick sections of the absorbent material, and covering it all with ¾-in. plywood panels. Linoleum was then added.

A 1-in. gap was left between the walls and the new flooring to stop vibration transmission from the walls.

Stainless Bearings For Thrust Reversers

A special grade of stainless steel is used in the pivot bearings of thrust reverser doors in the jet engines of the Boeing 720 and 707.

Brakes reverse jet exhaust

The thrust reverser mechanisms consist of a pair of gates, called "clamshell doors" mounted aft of the engine turbine. When closed, the clamshells block the exhaust and force it out cascade vanes through both sides of the engine pods to help brake the aircraft.

The stainless steel bearings and races used to open and close the doors, withstand compressive stresses

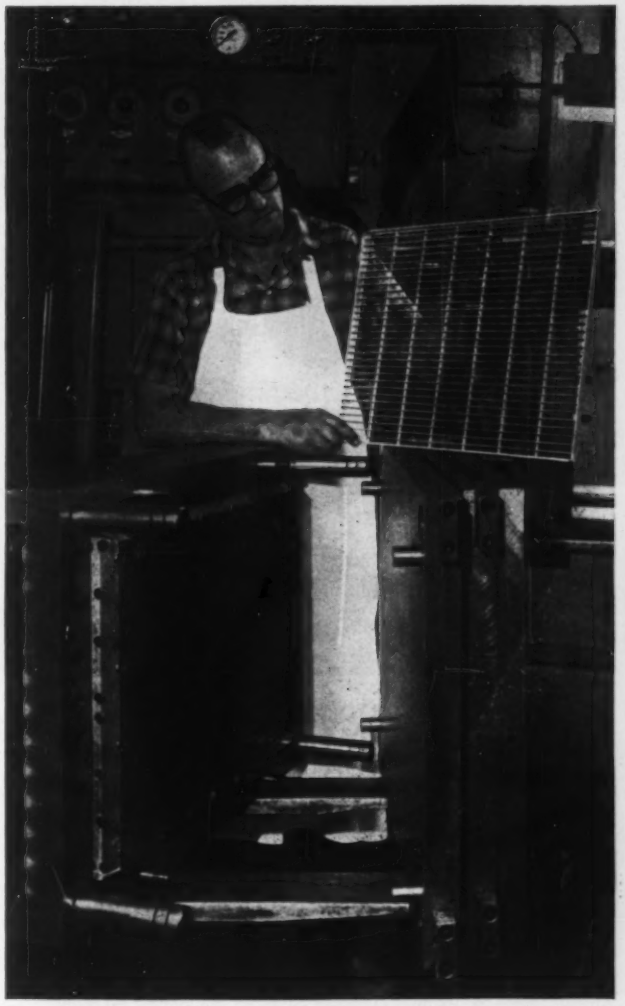
Emergency oxygen dispenser about 4 in. in dia replaces units weighing 125 lb. New high strength columbium steel tanks developed by Great Lakes Steel Div. of National Steel Corp. provide 1 hr of oxygen at a rate controlled by the patient's own breathing. Spherical shape, and the ability of the steel to withstand brazing heats up to 2100 F, enable the container to hold 20 gal of oxygen at 1790 psi.

Tool Steel Topics

BETH EHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Plastic grille for air conditioner molded IN A BREEZE with Lustre-Die



This plastic grille for an air conditioner was molded at the rate of one per minute by Midwest Plastics Corporation, Wichita, Kansas. Using a die made of Lustre-Die tool steel, they produced a perfectly formed grille, with a high sheen. The grille measures 21½ x 15 in., and is ½ in. thick.

Why Lustre-Die is ideal for plastic molders

Lustre-Die tool steel is ideal for plastic molders because it can be put right to work, without the need for heat-treatment. It's easy to machine, and it polishes beautifully . . . making possible an eye-appealing sheen on finished plastic parts.

Lustre-Die is an electric furnace steel. It has a well-balanced basic analysis. By adding a special alloy fortification, which increases its depth of hardenability, its fine mechanical properties are further improved. Because Lustre-Die is heat-treated in the mill by means of oil-quenching and tempering, it comes ready for machining and polishing. It is also carefully controlled during manufacture to insure freedom from porosity.

You can always count on a fine molding job when you use Lustre-Die. But don't take our word for it. Put Lustre-Die to work in a trial run. Your Bethlehem tool steel distributor can supply you.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Watch Out for Abrasion Caused by Scale

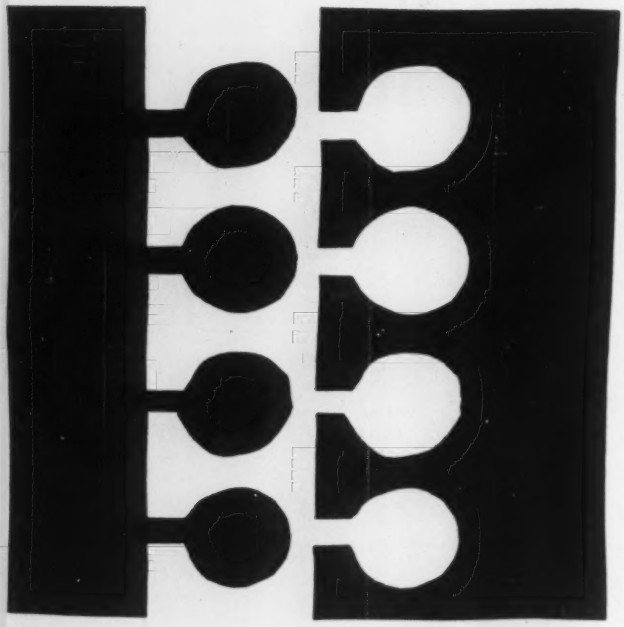
When punch-press operators are occasionally unable to obtain the required sheet stock in the usual cold-finished form, they substitute hot-rolled stock. However, this causes the service life of the punches and dies to drop to one-half or one-third of normal, or less. This result is largely due to the abrasion of the scaled hot-rolled surface on the cutting edges of the tools. Determining whether such a substitution is economical depends upon the results which are expected, and the cost, of each individual job.

One frequently hears the question: "What can be done in tooling to avoid this decrease in production?"

When punches and dies are normally made from water-hardening carbon tool steel (W-1 or W-2), or from manganese oil-hardening steel (O-1), the shortening of tool life can be avoided by changing to a high-carbon high-chromium tool steel, such as Bethlehem Lehigh H (D-2). This change usually overcomes the disadvantage of using the hot-rolled scaled stock.

However, if high-carbon high-chromium grades are already being used, there is only one method by which an appreciable improvement can be realized—the use of special heat-treatment operations. Typical treatments are short-cycle hardening, and nitriding. Complete details regarding these types of treatment may be obtained by writing Bethlehem Steel Company, Bethlehem, Pa.

For more information, turn to Reader Service card, circle No. 336



super accuracy on complex parts

Need tolerance of 1/100,000″? Machine it!

But for many alloy parts requiring accurate shape, investment casting is the economical answer. We'll make most any shape to your specs—and maintain accuracy throughout.

If you're intrigued, dispatch a sketch of the part to Westinghouse Electric Corporation, Metals Plant, Blairsville, Pa. We'll take it from there. Shell-mold and vacuum casting also available.

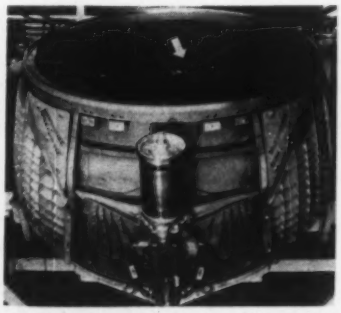
J-05014

Westinghouse investment casting minimizes machining yet maintains required tolerances on this unloading comb that must match a mating piece.

You can be sure... if it's

Westinghouse

For more information, turn to Reader Service card, circle No. 448



Thrust reverser clamshells *pivot on high temperature stainless steel bearings (arrow). Cascade vanes that vent the reversed gas flow are in the pod wall.*

of more than 600,000 psi and temperatures over 800 F during landing and stopping.

The steel, a modification of AISI 440-C stainless, was developed by Latrobe Steel Co., Latrobe, Pa. The alloy composition is 1.10 C, 0.30 Mn, 0.30 Si, 14.50 Cr and 4.00% Mo. Increasing the molybdenum content of 440-C stainless from about 0.005 to 4.00 provided the necessary hot hardness for the braking operation.

Reversers cut landing distance

Effectiveness of thrust reversing as a brake was shown in test flights by Boeing. The new 720, in simulated short-field landings, came to a full stop within 2200 ft after touchdown using both thrust reversers and wheel brakes.

Flush Printed Circuit Wins CABRA Award

A process for producing printed circuits in which the copper conductor is flush with the insulating backing and mechanically bonded to it has won the 1960 Copper and Brass Achievement Award.

The circuits, invented by R. M. Bell and Athan Stosuy, are expected to find wide usage in automotive circuits and electronic equipment where high electrical conductivity is required but space is limited. Because the conductor is flush with the backing, the circuit is said to be exceptionally resistant to mechanical, chemical, electrical

PRODUCT-DESIGN BRIEFS FROM DUREZ

- Something extra in molding compounds
- Fire-retardant structural plastic
- News notes for designers

Upgrading a product

Good • Plenty of distributor caps are molded of Durez general-purpose phenolic. When cost is a prime factor, general-purpose does the job and does it well.

Best • However, if you're shooting for something extra in a distributor cap (or in almost any electrical part), take a look at *Durez 2271*. This is an electrical-grade phenolic. A ⅛" test disk of it withstands 12 kv at 180° F in air for an hour or more without puncturing. The cost of this extra performance is low: weighing less than comparable electrical-grade materials, *2271* gives you more pieces per pound.

Good • You'd be right in choosing *Durez 791 Black* for a piece like this telephone handset. You'd be able to count on low molding cost because of *791's* fast cure. You'd get the required physicals in good balance. And the price of this wood-flour-filled material is low.

Best • Then why do telephone men favor a different material, *Durez 17225*, for handsets? Because this wood-flour-and-flock-filled material provides even higher resistance to impact fractures. The rich black finish presents an unyielding front to moisture and body acids. Bonus: a part that *more* than meets the specs—for fractions of a penny per piece.

We could go on and on giving you case histories like these. Have you looked into the extras you can build into a product—at next-to-invisible cost—with Durez molding materials? To get a better idea of what these compounds can do for you, send for our illustrated 8-page Bulletin D400 listing properties, uses, advantages.

CONSOLITE (CONSOLIDATED GENERAL PRODUCTS, INC.)

Safer skylight

Here's a plastic skylight that retards fire.

It's made for use in hazardous locations or wherever building codes are exceptionally strict.

The material is fibrous-glass-reinforced Hetron®. It will ignite only under direct hot flame, and snuffs out as soon as the flame source is removed.

Weighing only half a pound per square foot, the skylight material will support a uniform load of 150 pounds per square foot. It is thermally stable from −65° to 200° F, and has great strength and shatter resistance even at subzero temperatures.

Its thermal conductivity is only ⅕ that of glass, yet it can transmit ⅘ as much light as glass without glare. It delivers greater insulating effect than other skylight materials, at lower cost.

Could any of these attributes help *you* design a better product? Hetron® is hard at work already in radomes, chemical ducts, blowers, boat hulls, housings, fume hoods, window panels, canopies. Data on self-extinguishing Hetron resins is yours for the asking.

On keeping abreast

How can a man keep up with all that's new in thermosetting plastics?

Well, it isn't easy. But we can help. We mail out every 60 days a bulletin, *Durez Plastics News*. You can read it in 10 minutes. It gives a bird's-eye view of what's new in the use of Durez plastics. Every item is *news*—hot off the presses of leading molders the country over, whom we visit regularly.

To get this bimonthly packet of ideas and information, just check the coupon.

For more information on Durez materials mentioned above, check here:

- ☐ Phenolic molding compounds (8-page Bulletin D400).
- ☐ Hetron fire-retardant polyester resin (data file).
- ☐ *Durez Plastics News* (mailed bimonthly).

Check, clip, and mail to us with your name, title, company address.
(When requesting samples, please use business letterhead.)

DUREZ PLASTICS DIVISION

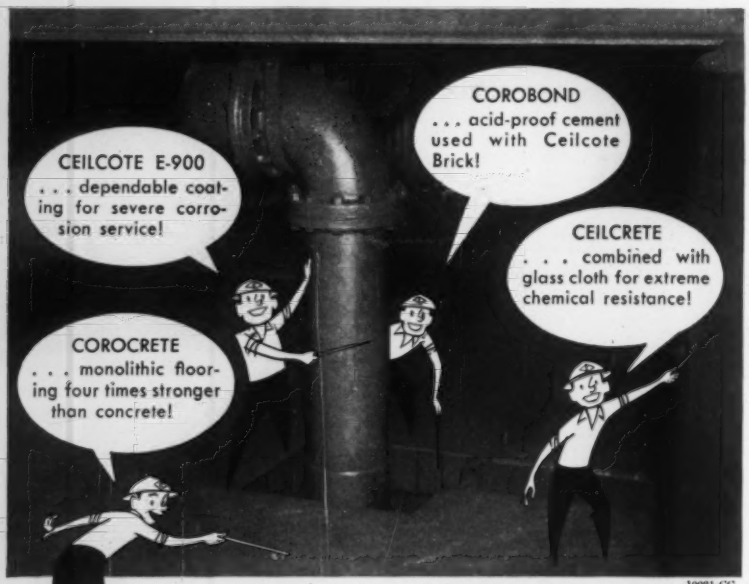
1412 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

For more information, turn to Reader Service card, circle No. 353

STOP COSTLY CORROSION DAMAGE...


CEILCOTE E-900
. . . dependable coating for severe corrosion service!
COROBOND
. . . acid-proof cement used with Ceilcote Brick!
CEILCRETE
. . . combined with glass cloth for extreme chemical resistance!
COROCRETE
. . . monolithic flooring four times stronger than concrete!

10921-CC

WITH CEILCOTE

ENGINEERED FLOORS

Ceilcote *Engineered Floors* are the answer to costly floor maintenance problems caused by acid and alkali attack. And Ceilcote floors are engineered to withstand impact, thermal shock, abrasion and expansion without cracking or spalling! The installation shown above exemplifies Ceilcote's comprehensive approach to individual flooring problems . . . demonstrates how Ceilcote materials are carefully integrated to completely protect all types of surfaces. Working under contract, competent Ceilcote engineers analyze your operating conditions . . . formulate materials . . . direct surface preparation and installation by Ceilcote construction crews. Some installations can be installed under Ceilcote supervision or by plant personnel. *This complete flooring package with guaranteed performance is available only from Ceilcote!*

Write today or call your nearest Ceilcote Representative . . .

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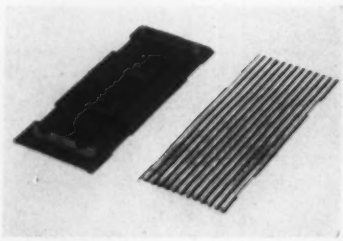
CEILCOTE

THE CEILCOTE COMPANY, INC.
4899 Ridge Road • Cleveland 9, Ohio

For more information, turn to Reader Service card, circle No. 339

MATERIALS AT WORK



***Molded circuit** is bonded flush with insulating backing.*

and thermal effects.

Basic steps in making the new molded circuit involve: 1) coating a 0.003-in. thick copper strip with a single particle thickness of copper or bronze powder; 2) fusing the powder to the strip at a temperature of about 1600-1900 F; and 3) molding the plastic insulating backing material to the sintered particle side of the copper strip. The sphere-shaped particles mechanically bond the strip to the backing. Any thermoplastic or thermosetting material can be used.

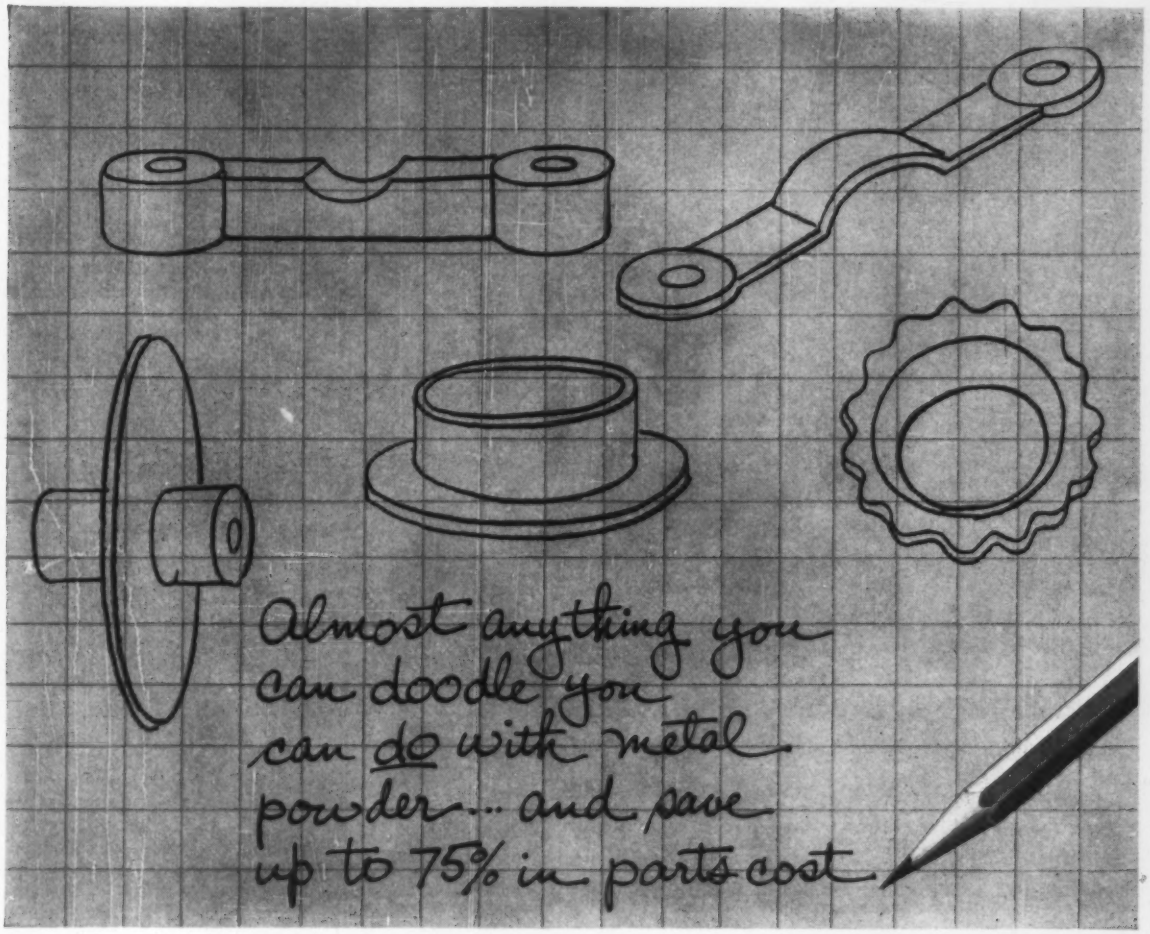
A typical application of the new molded flush circuit is shown in the accompanying photo. Wire brushes are pulled over the smooth surface of the component, thus insuring proper electrical and mechanical performance.

Other advantages of the process include: 1) ability to be fabricated in almost any shape; 2) elimination of costly drilling by providing molded-in holes; and 3) ability to be fabricated and machined at higher temperatures due to the absence of adhesives.

Auto Fuel Filter Housed in Molded Nylon

Gasoline filter housings for Plymouth, Dodge, De Soto, Chrysler and Imperial automobiles are now being made of molded nylon.

The filter, installed between the fuel pump and the carburetor, prevents dust and other foreign particles from clogging the carburetor. According to Spencer Chemical Co., the filter housing was approved for 8-cylinder engines after two years of



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HOW THE SILICONES MAN HELPED AMERICA KEEP ITS DATE WITH THE JET AGE

As your jet air liner streaks aloft today, UNION CARBIDE Silicones are aboard to help. Silicones aided in its manufacture, too. The giant tires GOO slipped easily from their original molds because of silicone mold release agents. Polyether foam seat cushions were formed under the near-ideal control of silicone surfactants. Soft, flexible oxygen masks, of oxygen-and-ozone-resistant silicone rubber, fit facial contours without irritating the skin. Silicone fluids damp out vibration in vital, sensitive instruments. Silicone rubber door seals never lose resiliency even in extreme temperatures, won't harden or shrink. This constant flexibility makes it the basic material in blankets used for construction of honeycomb structural panels, also in grommets, gaskets, and O-rings. And in the flexible hoses in hot-air jet-engine starters. You'll find jet aircraft radio and radar wires insulated with electrically resistant silicone rubber. Piston plane and helicopter ignition wiring, too. Also the boots for helicopter control sticks, many other parts. This is only a smattering of what silicones have been doing for just one industry—aviation. Is your business enjoying equal benefits? We suggest you contact the UNION CARBIDE Silicones Man. Address: Silicones Division. Dept. LM-0002, Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y.

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testing indicated that it could resist wide temperature changes (from −40 F to 250 F), extreme vibrations, and the corrosive effects of automobile fuels.

The filter housings are molded in two halves. After a pleated paper filter is inserted, the halves are spin-welded together.

Sintered Metal Liners Brake Jet Wheels

Wheel brake disks made from sintered iron-ceramic compounds have been specified for Lockheed Aircraft Co.'s Jetstar transport brake system.

In a sudden stop, each wheel brake must be able to convert 34 million foot-pounds of kinetic energy to heat and then quickly dissipate the resulting 2000 F heat. In addition, the brake disks must be able to withstand temperatures as low as −65 F and 100% humidity in the form of condensation and frost, abrasion by sand, salty atmospheres, and shock and vibration.

Liners bonded to steel disks

According to Raybestos-Manhattan Inc., the friction material used in the brake linings is a combination of ceramics—for hardness and wearability, and metals—for heat dissipation.

Brakes operate hydraulically

The four main wheels are equipped with hydraulic, piston-actuated brakes made by B. F. Goodrich, Aircraft Products Div. The friction material in the brake is bonded to both faces of rotating disks keyed to the wheel and separated by stationary disks.

***Wheel brake assembly** for jet landing gear has lined sintered iron rotors alternating with steel stators. Assembled hydraulic brake is shown in back.*

Flame sprayed metal increases wear resistance better than 10 times

AIDS WEIGHT REDUCTION

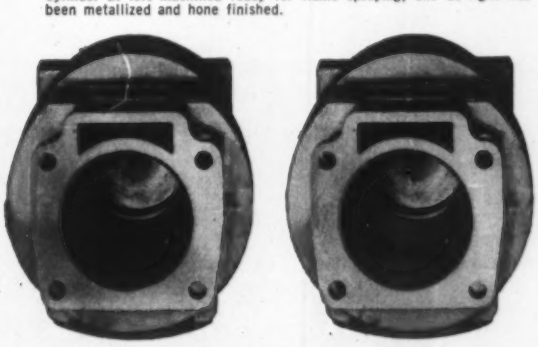
Automatic setup for metallizing inner walls of aluminum cylinders used in lightweight gasoline engines. Cabinet in foreground houses six-station rotary setup; automatic control panels are at right.

Many methods, including cast-iron cylinder liners and chrome plating, have been tested for wear resistance in lightweight gasoline engine blocks of aluminum.

Best of these methods experienced breakdowns in less than 400 hours. Now they are metallized with METCO Sprabond (molybdenum alloy) as a bonding agent, followed by a coating of sprayed steel alloy.

Test runs of over 4,000 hours show little or no wear of the metallized surface. Finish thickness is .007"; weight—a few grams. Cast-iron liners weighed almost ½ pound.

Cylinder at left machined ready for flame spraying; one at right has been metallized and hone finished.



Closeup of automatic six-station rotary setup. Cylinders are individually rotated at 150 rpm. Cylinder is loaded on table at Station 1, moved through Stations 2 and 3 for pre-heating by torch. At Station 4, bonding coat is applied by the gun nozzle which feeds into the rotating cylinder. Low alloy steel is applied at Station 5 and cylinder cools at Station 6. Cylinder walls are finished by honing.

New engineering data bulletin

Bulletin 136B—The METCO Flame Spraying Processes, provides basic engineering and application data on flame sprayed coatings of metals, ceramics, carbides and other high melting point materials. 16 pages. Send coupon for free copy.

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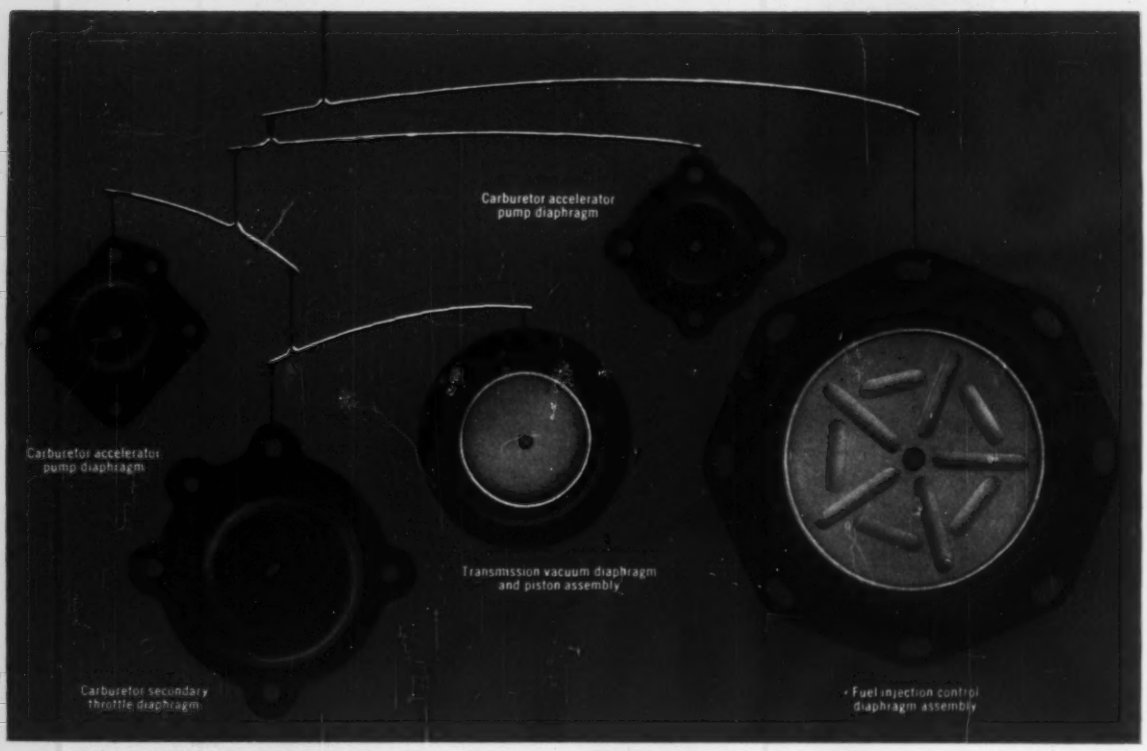
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Carburetor accelerator pump diaphragm
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cont'd from p 112

hibit their acquisition for short production runs. In such cases it is possible to use a simple dry ice-ethanol bath which is both inexpensive and easy to control.

What about cold rolled material?

In the CRT and SCCRT cold rolled and tempered conditions the alloys are used largely for applications such as missile skins, resistance welded sandwich structures, valve diaphragms, etc. In such applications high strength and rigidity are the principal design criteria; formability can be sacrificed to obtain them. A distinct advantage, in addition to high strength, for users of CRT and SCCRT material: alloys are fully heat treated at the supplier's mill and shipped ready for use on the production line without any further treatment.

AM 355 bar stock

Heat treatment of AM355 bar varies somewhat from that of sheet and strip as shown in the second flow chart (p 111). Bar stock does not have to be formable but it should be easy to saw and machine. Bar stock is therefore heat treated to improve machinability rather than formability.

Thus, instead of being H-annealed, bars are hot worked to size and finished at a maximum of 1800 F in order to obtain a fine grained microstructure. "Equalization" at 1425 F followed by cooling to room temperature results in a uniform structure of chromium carbide particles scattered through a matrix of low carbon martensite. Overtempering at 1050 F reduces the hardness to Rockwell C35. In the equalized and overtempered (E + O) condition, AM355 bar can be readily machined.

Final hardening to produce the SCT or DA condition is similar to that for sheet and strip. Overtempering of *hardened* material at 1000 F also results in good machinability.

Data in Table 4 (p 112) show that bar stock in the SCT condition is stronger and somewhat more ductile than material in the DA condition.

Synthetic Ruby Amplifies Light

The first true amplification of light has been achieved by Dr. T. H. Maiman and scientists at Hughes Aircraft Co. Their announcement was shortly followed by a similar one from Bell Telephone Laboratories.

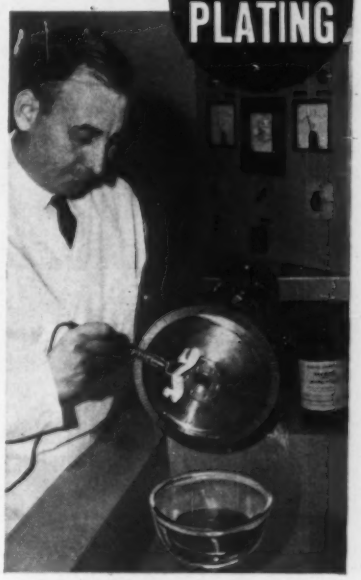
Both devices, called lasers (light amplification by stimulated radiation) stimulate solid-state reactions in synthetic ruby to produce high-intensity light pulses in a very narrow beam.

Materials uses foreseen

Because the intense beam can be focused to a needle point it is possible that its light and heat can be used to induce chemical and metallurgical changes in surfaces of materials, Hughes Aircraft scientists say. Other uses they suggest are; 1) investigating properties of matter and performing basic experiments in physics; 2) producing high-intensity beams for space communications; and 3) vastly increasing the number of communication channels available

***Laser light amplifier** emits an intense beam when the helical photoflash tube excites atoms in the synthetic ruby rod.*

MIS-MACHINED PARTS SALVAGED WITH DALIC PLATING



DALIC Nickel Plating the out-of-tolerance portion of superalloy turbine wheel to specification size.

Dalic Plating has become a recognized manufacturing method for rebuilding undersized sections of products to meet specifications. Many of America's largest companies are using Dalic Plating to restore mis-machined products to their full value.

You can build-up exact areas on components including flat surfaces, inside and outside diameters, grooves, etc. Plating thickness can be controlled accurately.

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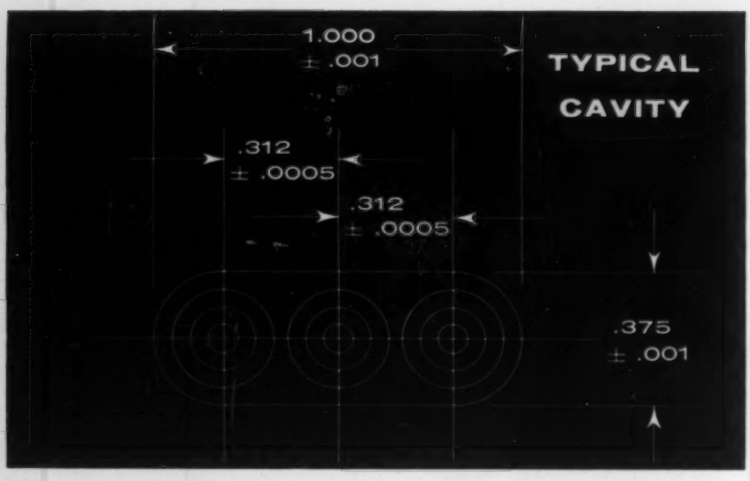

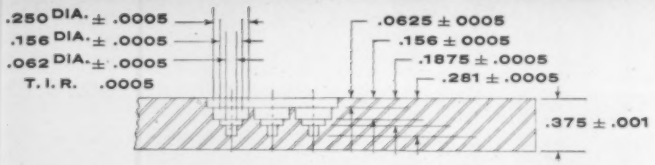

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by projecting the radio spectrum 10,000 times higher than at present.

Ruby excited by flash lamp

The synthetic ruby rod, about ½ to 2 in. long and from ¼ to ½ in. dia, has both ends polished until extremely flat and parallel, then partially silvered.

The ruby is placed in the center of a powerful spiral photoflash lamp and illuminated with a single flash of white light. When the flash is intense enough an almost parallel beam of monochromatic light is emitted through the silvered ends of the ruby in intense, short bursts of about one millionth of a second duration.

An earlier development by Hughes Aircraft uses synthetic rubies immersed in liquid helium to amplify faint radio signals (see M/DE, Sept '60, p 179).

Cold Rolling Hardens, Strengthens Titanium

Cold rolling electrorefined, magnesium-reduced or sodium-reduced titanium increases the strength and hardness of the high-purity metal.

J. D. Ramsdell and E. D. Hull, of the U. S. Bureau of Mines, found that the three types of titanium did not harden excessively from cold rolling: both tensile and bend ductility were good for reductions in thickness up to 80%.

During annealing, softening occurs between 750 and 1110 F. Magnesium-reduced and electrorefined titanium are fully annealed after 30 min at 1290 F. Sodium-reduced titanium fully anneals after 30 min at 1470 F.

Rugged Fabrics Tested with Cannon

A 75-mm cannon has been developed to test the impact strength of exceptionally strong fabrics and other materials. The helium-activated gas gun fires at specimens mounted in a heavy pendulum.

The 30-ft long ballistic range was developed by Fabrics Research Laboratories, Inc., Dedham, Mass. for the Air Force as part of a program

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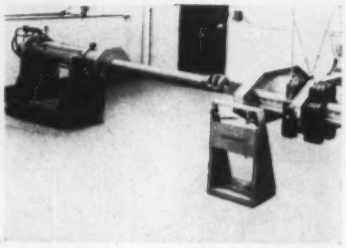
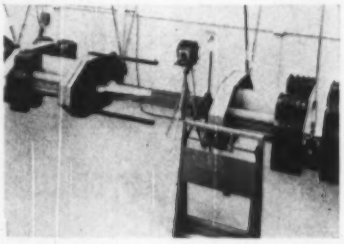


Ballistic tests *of extremely strong structures are made by firing a projectile from the cannon (left) through a specimen mounted in the pendulum (right).*



The projectile *passes through the displaced pendulum (left) and is caught by a second pendulum (right) Note the flash photography setup.*

to develop parachutes and similar drag devices to slow space craft for re-entry into the atmosphere.

The test range is an outgrowth of a program using .22 caliber projectiles to test yarns and fibers. Because entire systems can be accommodated, it is said to be useful for carrier arresting nets for jets, crash helmets and safety belts.

The new equipment is said to be significant for two basic reasons: 1) it is used to test large samples having up to 10,000 lb static strength; and 2) to obtain precise measurements for accurate calculation of stress-strain relationships.

Pendulums measure impact speed

A 75-mm projectile, weighing from 4 oz to 10 lb, is fired from a 10-ft long gas gun at a predetermined velocity up to 800 fps and with a force up to 200,000 lb.

The test specimen is clamped in the jaws at the far end of a pendulum which is weighted up to one ton. The projectile strikes and breaks the specimen and is caught by a simi-

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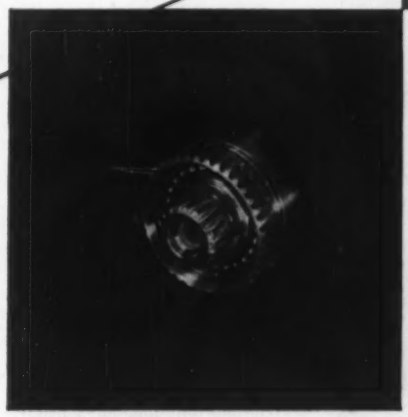
steel goes to work



Thrust reverser bearing assemblies, made of Latrobe's Vac-Arc BG 41 Stainless, take compressive stresses of more than 600,000 psi and temperatures in excess of 800°F. as new Boeing 720 jetliner brakes to a stop. Bearings by Torrington Co.; Thrust Reversers by Rohr Aircraft; Jet Engines by Pratt & Whitney Aircraft.

VAC-ARC BG 41 "hot hardness" withstands critical braking action of new Boeing 720

Through the use of thrust reversers and wheel brakes, the new Boeing 720 has been brought to a full stop within 2200 feet after runway touchdown—bringing high speed jet service to restricted runway facilities throughout the world.

The thrust reverser bearing assemblies, made of Latrobe's new Vac-Arc BG 41 Stainless (modified Type 440 C), withstand the critical stresses at elevated temperatures imposed by the braking action of reversing the jet engine thrust.

Here's another example of Latrobe Metalmasters meeting the challenge for super steels in the jet and missile age. Vac-Arc Steels (consumable electrode vacuum melted) continue to set new standards for cleanliness, homogeneity and high strength.

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How
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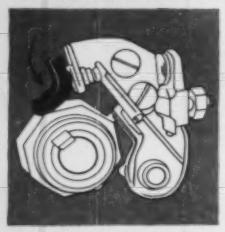
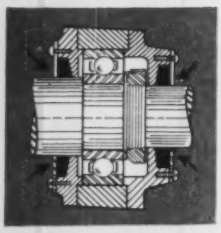
SEALING and LUBRICATION

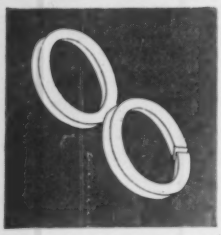
DuFelt is a laminated combination of Felters' felt and Hycar; and is recommended for sealing of lighter oils when no head exists. Seals and lubricates at the same time; and offers improvements over other materials.



Felt is an ideal wicking and lubricating material which can be designed into special assemblies like this distributor cam shown here. Lubrication is constant, wear reduced, and felt can be shaped to cover all required areas.

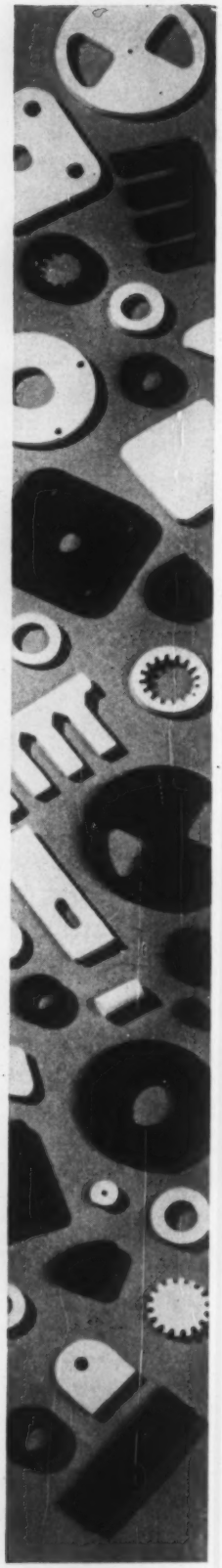


Lifetime bearing lubrication is now possible by selection of correct SAE grade, and designing into sealed bearing. Felt filters out contamination and works as combined reservoir and wick, directing oil flow to required areas.



Mechanical felt seals permit a close seal without undue pressure. Felt can be waterproofed and provides superior grease and oil retaining and dust, dirt and grit exclusion.

To help you get the most out of FELT, send for the Felters' Design Book. Write, today.



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larly weighted pendulum. The deflection of both pendulums is precisely measured as the index of projectile velocity. The amount the specimen slows the projectile is a measure of its impact strength.

Stop photography records test

Just before the missile hits the target it triggers a multi-microflash photographic unit that makes up to 15 separate flashes of one millionth of a second duration. These progressive exposures are recorded by an open shutter camera on a single photographic plate.

Cermets Strengthened By Metal Fibers

Metal fibers can effectively reinforce cermets, and possibly other ceramic materials, and such reinforcement contributes to impact strength, according to a report from Alfred University.

Two general types of ceramic-metal composites were investigated.

1. The "microcracked system" in which the thermal expansion of the ceramic exceeds that of the metal so that the ceramic develops a network of fine cracks on cooling after hot pressing.

2. The "noncracked system" in which the expansion of the ceramic equals or is less than that of the metal. Both systems have desirable characteristics although, in general, the noncracked system seems slightly superior.

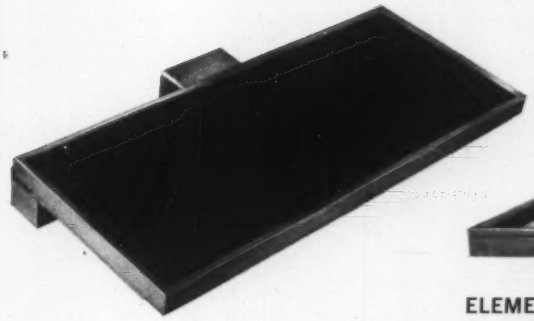
Microcrack composites such as alumina - molybdenum fiber retain high strength through thermal cycling. The strengths, however, are lower than that of the matrix ceramic prior to cycling; experience gained in the tests indicates that higher strengths may be obtained in the noncracked systems.

Noncracked stronger

Noncracked systems, e.g., a mullite-alumina body with molybdenum fiber, may be made stronger than the ceramic. So far the ceramics tested have elasticities in the same range as the metal. Ceramics with lower elasticity may offer a distinct advantage.

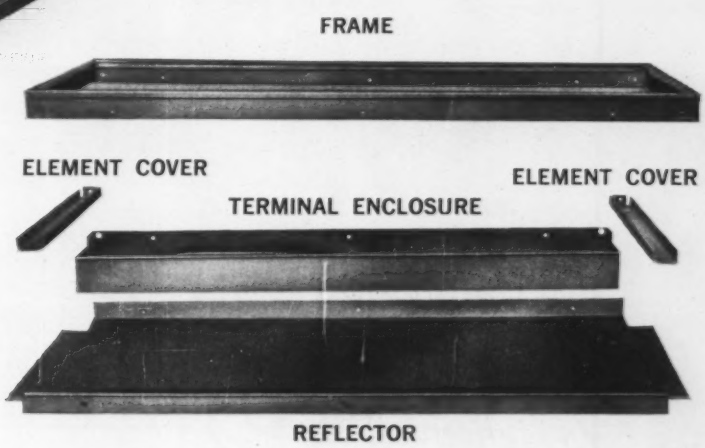
Alfred University researchers also found that the higher the volume of

Economical, reflective Armco ALUMINIZED STEEL gives multiple benefits in new infrared heater



COMPLETE UNIT

This new self-contained infrared heating unit is used for drying, baking, curing, and preheating. The heating element is tempered glass coated with an electrically-conductive film. The long-wave-length heat given off is readily absorbed by materials of all colors. All major metal parts—reflector, frame, terminal enclosure and element covers—are made from Armco ALUMINIZED STEEL Type 1.



This new self-contained infrared heating unit heats quickly and uniformly, requires minimum maintenance, remains permanently strong—yet is built at reasonable cost. The reason: nearly everything except the glass is fabricated from Armco ALUMINIZED STEEL Type 1.

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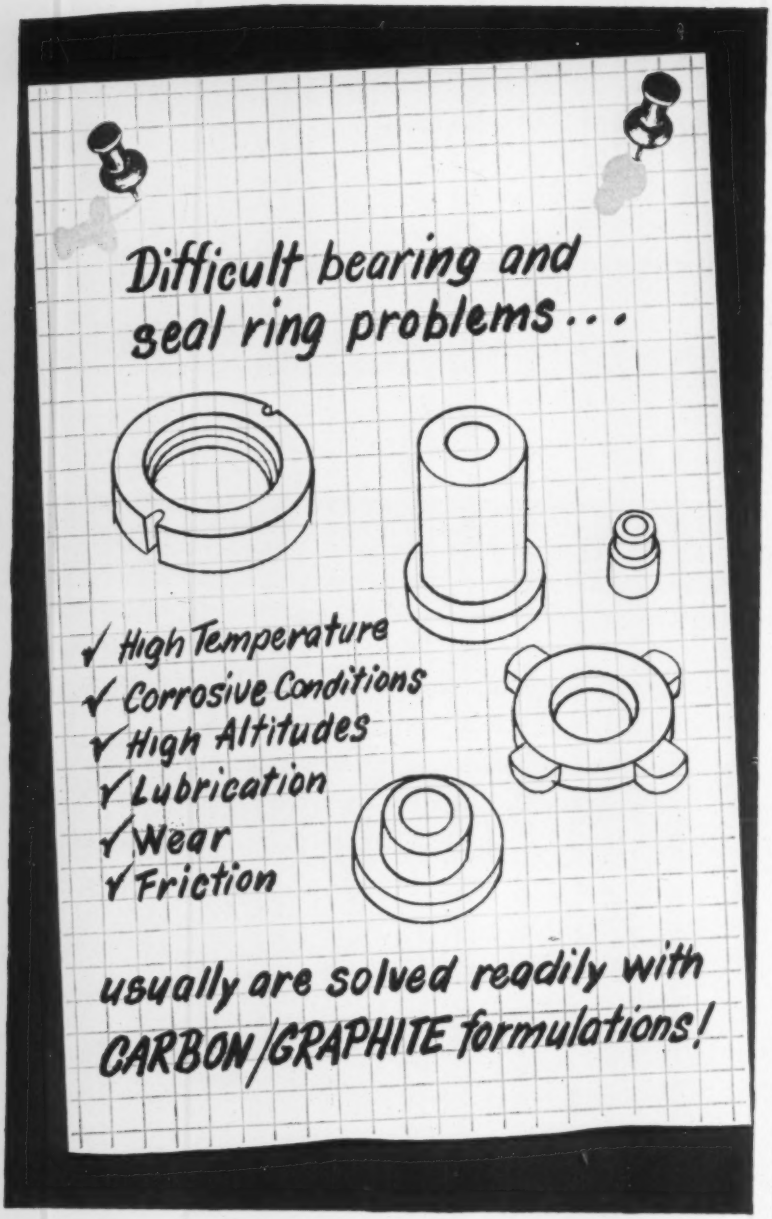

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fiber incorporated in the composite, the higher the flexural strength. It was possible to hot press a sound composite containing fiber in amounts up to 43%.

Full details can be found in OTS Report PB 161481, obtainable from Office of Technical Services, U. S. Dept. of Commerce, Washington 25. D.C.

Dense Hafnium Carbide Is Hot Press Formed

Powdered hafnium carbide has been hot pressed to 98% theoretical density in a program to develop useful mechanical strengths for the compound.

Hafnium carbide is potentially valuable because it melts at 7030 F, the highest temperature known for any metal or simple metallic compound. However, little research has been done on it, and the best bodies previously produced were said to have approximately 20% porosity and, consequently, low mechanical strength.

Dense test specimens needed

In the research program at Lewis Research Center of the National Aeronautics and Space Administration the first step was preparation of high density test specimens. Samples of −325 mesh hafnium carbide powder were solidified in an inductively heated hydraulic press. The ranges investigated were: temperature, 3500 to 4870 F; pressure, 1000 to 6030 psi; and time, 5 to 60 min.

It was found that bodies of approximately 98% theoretical density can be hot pressed at 3500 psi and 4230 F for 15 min. Higher temperatures do not improve density but accelerate the rate of grain growth. Increased pressure has little effect on density and grain growth and longer pressing times only increase grain growth.

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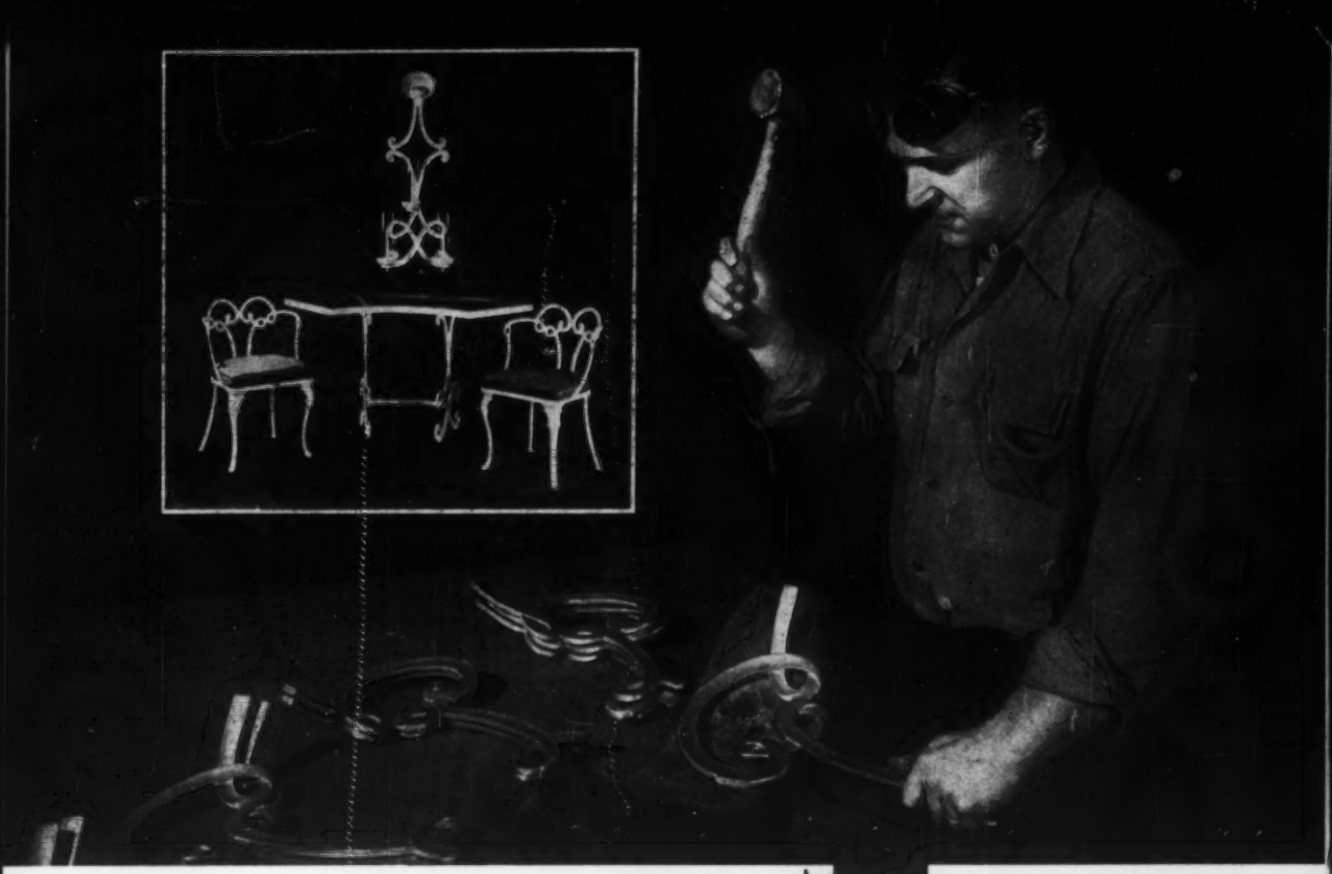

Adaptaloy castings are easily cold formed and simplify assembly for the Sandfort Furniture Co., N. Y. Inset photo illustrates one of Sandfort's cast aluminum furniture settings—all are cast of Adaptaloy.

Highly workable and tough!

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Liberty 2-0797

CHICAGO, ILL. (WHITING)
Chicago: Essex 5-5000
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For more information, turn to Reader Service card, circle No. 327

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The specifications for this executive cafeteria called for all kitchen metal surfaces, both exposed *and* unexposed, to be constructed of stainless steel. Only *lifetime* stainless steel can offer the durability and ease of maintenance necessary for maximum sanitation in food handling.

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TECHNICAL LITERATURE

(cont'd from p 47)

Books

Thermoelectric Materials and Devices. *I. B. Cadoff and E. Miller, Reinhold Publishing Corp., New York. 1960. Cloth, 6 by 9 in., 344 pp. Price $9.75*

An authoritative survey of recent progress made in the development of new materials for thermoelectric devices. Based on a special series of lectures presented at New York University, the book features the contributions of 20 experts, and ranges from basic theory to design of thermoelectric devices.

The book is divided into four sections: 1) theory of thermoelectric processes and circuits; 2) evaluation of materials; 3) materials currently being used and those being considered for future use; and 4) principles of thermoelectric device design, including descriptions of some experimental and prototype units.

The book should be of value to metallurgists, electrical and electronics engineers, and physicists.

Review of Metal Literature: Vol. 16. *American Society for Metals, Novelty, Ohio. 1960. Cloth, 6 by 9 in., 1266 pp. Price $20*

An annotated survey of articles, technical papers and reports that appeared in various books, and engineering, scientific and industrial journals throughout the world during 1959. The book is divided into 20 sections covering different areas of metal technology, and includes addresses of publications as well as comprehensive subject and author indexes.

ASTM Symposiums. *American Society for Testing Materials, 1916 Race St., Philadelphia 3.*

Symposium on Spectroscopy. *Special Technical Publication No. 269. 1960. Cloth, 6 by 9 in., 250 pp. Price $7*

Includes representative papers in six distinct fields of spectroscopy: 1) emission, 2) x-ray, 3) flame photometry, 4) ultraviolet absorption, 5) magnetic resonance, and 6) infrared spectroscopy.

Symposium on Durability and Weathering of Structural Sandwich Construction. *Special Technical Publication No. 270. 1960. Cloth, 6 by 9 in., 74 pp. Price $3*

Subjects covered include: 1) effect of normal aging on strength of glass fiber-reinforced plastics honeycomb cores, 2) service exnerience with sandwich construction, 3) effect of environmental exposure on adhesive-bonded structures, and 4) temperature rise in structures due to solar heating.

Symposium on Newer Metals. *Special Technical Publication No. 272. 1960. Cloth, 6 by 9 in., 223 pp. Price $7.25*

Three distinct topics are covered: 1) properties of refractory metals, 2) nuclear and light metals, and 3) processing of newer metals. The various papers discuss mechanical properties of molybdenum, tensile properties of the platinum-group metals, high temperature properties of tantalum, creep properties of beryllium, mechanical properties of yttrium, fabrication of columbium and tantalum, and effects of heat treatments on the tensile and corrosion properties of Zircaloy 2.

Symposium on Radioisotopes in Metals Analysis and Testing. *Special Technical Publication No. 261. 1960. Cloth, 6 by 9 in., 64 pp. Price $2.75*

Discusses metals analysis by radioactivation, principles of isotope dilution assays, neutron activation in the analysis of aluminum, and instrumentation for nucleonics.

Two Basic Books on Semiconductors.

Properties of Elemental and Compound Semiconductors. *Edited by H. C. Gatos. Interscience Publishers, Inc., New York. 1960. Cloth, 6 by 9 in., 450 pp. Price $8.50*

Contains papers presented at a recent conference sponsored by the American Institute of Mining, Metallurgical, and Petroleum Engineers. A main objective of the conference was to accent certain aspects of semiconductor technology in which this field borders on or overlaps with modern metallurgy.

The material in the book is grouped into five parts: 1) metallurgical and chemical aspects of semiconductor materials, 2) solid state and surface reactions, 3) chemical and lattice defects, 4) physical properties and device applications, and 5) role of dislocations in device properties.

The Surface Chemistry of Metals and Semiconductors. *Edited by H. C. Gatos, with the assistance of J. W. Faust, Jr., and W. J. LaFleur. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 537 pp. Price $12.50*

Subjects covered include: 1) electronic properties of metal surfaces; 2) electrical properties of the surfaces of semiconductors; 3) role of dislocations in the reactivity of solids; 4) etching of metals and semiconductors; 5) metal and semiconductor electrode processes; 6) dissolution of metals; 7) reaction of semiconductors with aqueous solutions; and 8) oxidation of metals.

Anti-Corrosion Manual: 1960 Edition. *Scientific Surveys Ltd., London, England. 1960, Cloth, 8 by 11 in., 400 pp. Price $9.50*

Various chapters in the book discuss corrosion in industry, corrosion resistant materials and their applications, preparatory treatments for protective coatings, protective coatings, spray painting methods, corrosion testing, protective packaging, cathodic protection, and British standards.

Introduction to Solids *L. V. Azaroff. McGraw-Hill Book Co., Inc., New York. 1960. Cloth, 6 by 9 in., 475 pp. Price $9.50*

Discusses the structure, nature and properties of inorganic crystalline solids. The book begins with a brief discussion of elementary crystallography. Then it considers how crystals form, how they grow, how they can be deformed elastically and plastically, how they interact with each other, and the different forms in which they can exist.

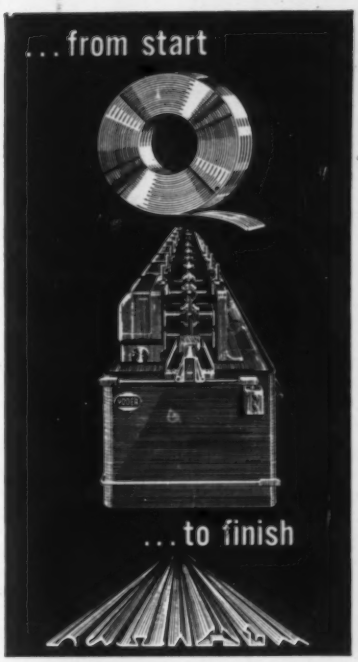
Runnerless Molding. *E. P. Moslo. Reinhold Publishing Corp., New York. 1960. Cloth, 5 by 7½ in., 172 pp. Price $4.95*

A concise survey of the theory, design, applications and economics of runnerless molding. The book describes in detail the injection molding of thermoplastics without the aid of a conventional sprue and runner system.

Reports

Acoustical fatigue ROLE OF STRUCTURAL DAMPING IN ACOUSTICAL FATIGUE. *W. J. Trapp, Materials Laboratory, and B. J. Lazan, University of Minnesota. Jan '60. 31 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1 (PB 161742)*

An analysis of the response of materials



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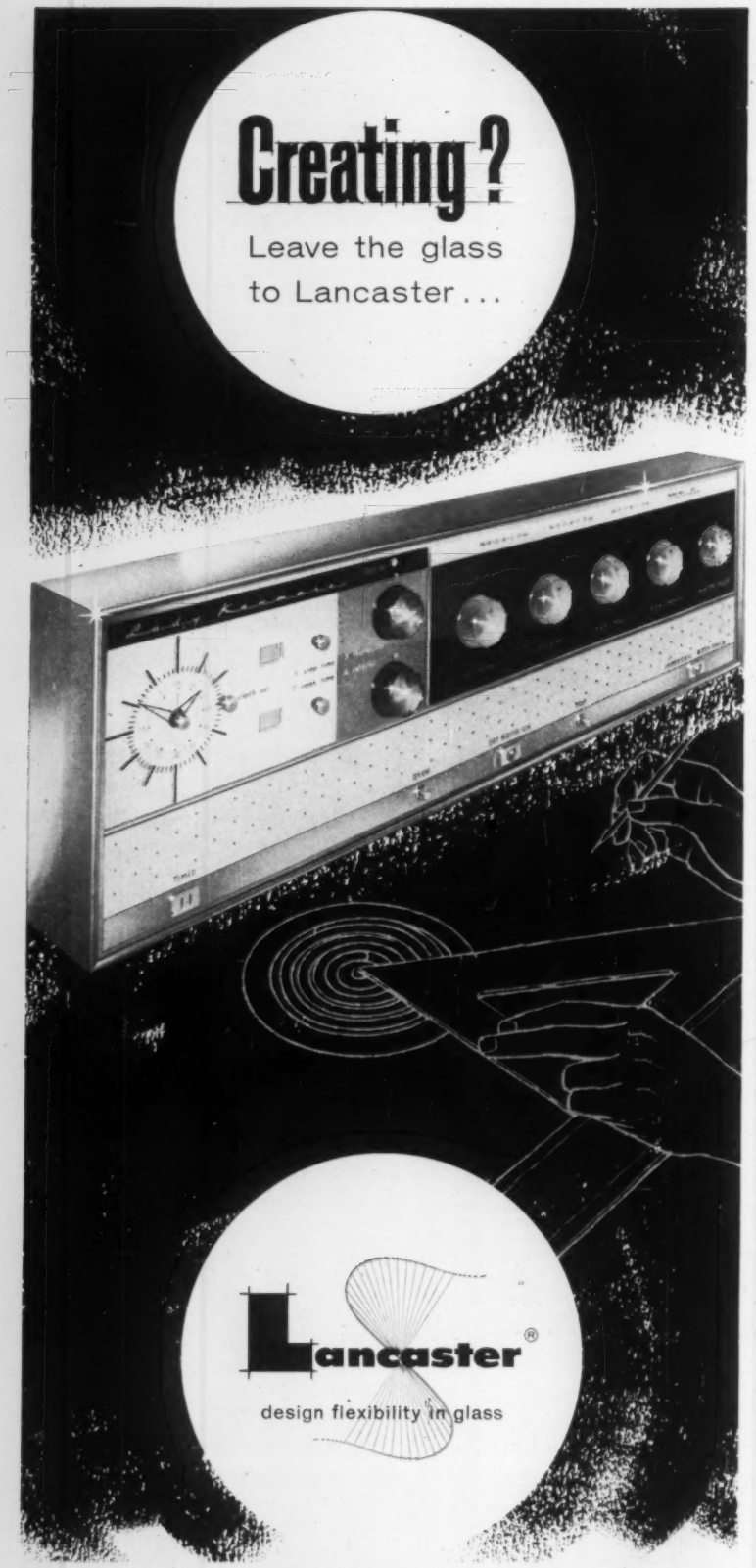

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TECHNICAL LITERATURE

and structures to high rates of acoustic energy. Included is a discussion of fatigue mechanisms and significant parameters. Advantages and disadvantages of various concepts and techniques are discussed and evaluated.

High temperature fabrics CANDIDATE MATERIALS FOR HIGH TEMPERATURE FABRICS. *Arthur D. Little, Inc. Sept '59. 146 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $3 (PB 161411)*

Development of high temperature fabrics for re-entry parachutes. Anticipated environmental and aerodynamic factors of re-entry from satellite orbits were used as a basis for the selection of candidate materials. All types of high temperature materials that could be made into fabric were evaluated, including metals, ceramics, glasses, inorganic and organic polymers, and single crystal systems (whiskers). Single crystals of metals and metal oxides probably offer the most for a high temperature fabric.

Thermal analyzer DIFFERENTIAL THERMAL ANALYSIS OF POLYMERIC MATERIALS. *H. C. Anderson, Naval Ordnance Laboratory. Feb '59. 28 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 75¢ (PB 161676)*

Describes a differential thermal analyzer that is an important tool in studying the thermal processes that take place when a polymeric material is pyrolyzed.

Inorganic structural materials REFRACTORY INORGANIC MATERIALS FOR STRUCTURAL APPLICATIONS. *H. A. Pearl and others, Bell Aircraft Corp. Feb '60. 151 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.75 (PB 161737)*

Thirty-five refractory inorganic material systems were tested for rupture, impact and thermal shock at room temperature to determine ways of using these materials in high temperature aircraft structural elements. The best system was based on 0.003-in. alumina-silica paper impregnated with alumina-silica cement.

Silicon carbide design MECHANICAL PROPERTIES OF SELECTED ALLOYS AT ELEVATED TEMPERATURES (PART 2: DESIGN CRITERIA OF SILICON CARBIDE). *H. S. Pearl and others, Bell Aircraft Corp. Mar '60. 134 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.75 (PB 161723)*

Nondestructive tests of silicon carbide were conducted to determine, in broad parameters, the areas where a brittle, nonmetallic body such as silicon carbide might be used in aircraft construction. Tests included density and density uniformity, dynamic modulus by sonic technique, x-ray diffraction under transverse load, electrical resistivity, and internal friction. Tables give manufacturers' property data for various types and forms of commercially available silicon carbide.

Materials at low temperatures MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS AT LOW TEMPERATURES: A COMPILATION FROM THE LITERATURE. *R. M. McClintock and H. P. Gibbons, National Bureau of Standards, June '60. 180 pp. Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50 (NBS Monograph No. 13)*

Includes tensile strength, yield strength, tensile elongation and impact energy of about 200 materials, given graphically as functions of temperature at temperatures down to -460 F.

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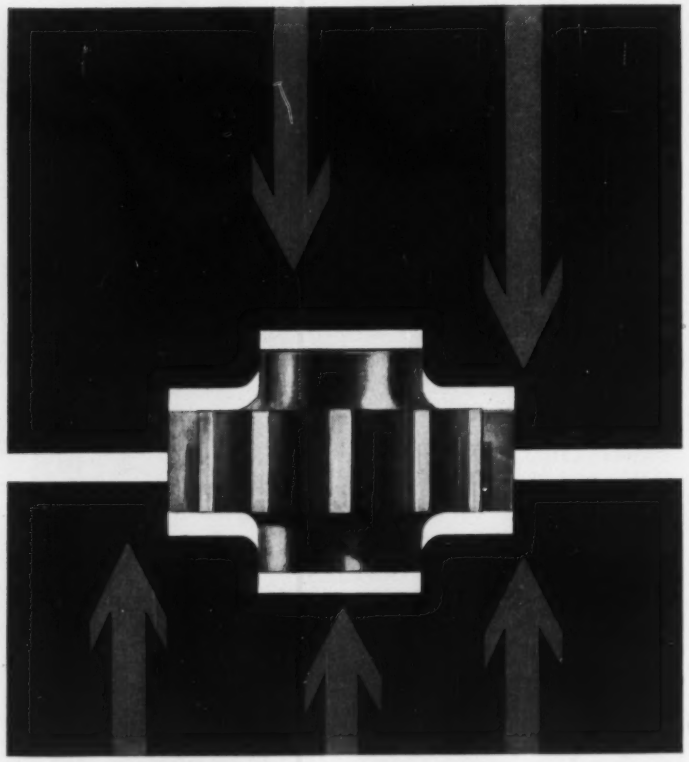

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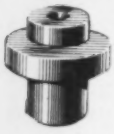

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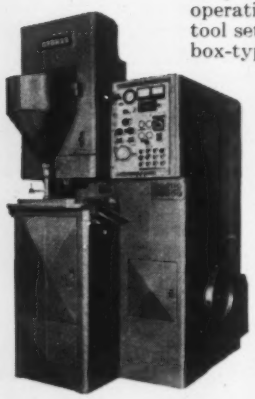
This 50-ton Stokes press gives you the multiple motions you must have for complex powder metal compacting . . . *without the expense and delay of manufacturing* and setting up complex tooling for *every job.* Stokes built-in motions give highest production of even the most complicated parts.

The Model 640 Powder Metal Press provides two upper and three lower compacting motions with underfill or resistance pressing controls. By simply positioning a selector switch and sequence dials at the control panel, the third lower motion can be set up as a resistance motion, a third lower punch, or as a stationary, movable, or ejecting core rod.

All press motions are precisely indicated and controlled from the central operating position in front of the press. Single cycle control simplifies tool set-up and facilitates compacting of parts with inserts. Rigid cast box-type frame overcomes deflections common in gap frame presses. Yet it provides accessibility for tool changing not available in four post presses.



For complete technical data on Stokes Model 640 50-Ton Multiple-Motion Powder Metal Press, write for Bulletin No. 1200. For any compacting or pressing job, no matter what the material, no matter what the size or production requirements . . . you can do it faster and more economically with Stokes equipment. Consult Stokes Engineering Advisory Service for complete technical assistance in designing parts, punches and dies, or complete production facilities.

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For more information, turn to Reader Service card, circle No. 434

(cont'd from p 18)

What's new IN MATERIALS

Colored Chromate Coatings

A chromate conversion coating process, although not new, is said to offer for the first time a practical, one-step method whereby ferrous and nonferrous metals can be chromate-coated in a variety of colors.

Previously, colored chromate coatings were obtained by immersing yellow and olive drab coatings in acidified organic dyes. Since the colors were not lightfast, they were used only for identification purposes or for indoor applications.

The coating process, called Hinac and originally developed by Heintz Mfg. Co. (M/DE, Aug '57, p 149), is available from Pennsalt Chemicals Corp., Metal Processing Dept., 3 Penn Center, Philadelphia 2. In addition to the color coatings, two types of clear coatings are also available.

The chromate coatings are applied in aqueous solution at room temperature by roller coating, dipping or spraying. Treated metal is then heated to 350-425 F for a few seconds to cure the coating. The producer says metal should be thoroughly cleaned before being treated by the process.

The three types

Color Hinac coatings are said to be hard, durable and corrosion resistant. One year of outdoor weathering in Florida and 2000-hr Weatherometer tests show colored Hinac coatings have good weather and fade resistance, and good gloss retention. The color coatings can be applied to carbon steel, aluminum, zinc, stainless steel, magnesium and other metals.

Hinac-1 clear coatings are said to be an excellent substitute for tin plate. They are applied in coating weights from 1 to 50 mg per sq ft. Steel, aluminum and galvanized steel coated with Hinac-1 can be welded better than untreated metal, according to the producer. The thin protective film has no dielectric properties and prevents surface resistance on metals.

Hinac-2 clear coatings are said to have good salt spray resistance, particularly when applied to aluminum and stainless steel. The coatings are applied in weights up to 400 mg per sq ft.

Potential uses

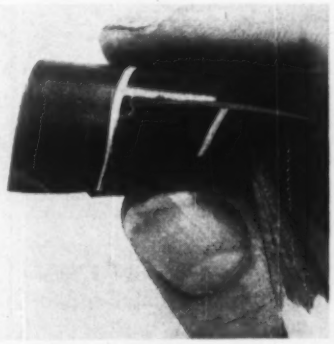
The producer says the Hinac series of chromate coatings can be used to prevent oxidation of aluminum and zinc, rusting of steel in storage, and staining of brass and copper. They can also be used as an after-rinse for phosphate coatings, electroplates and other types of coatings for improving corrosion resistance.

KEY NO. 606

Silicone Rubber Tapes Cover Irregular Parts

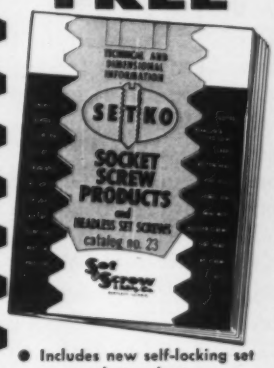
A new line of self-adhering, unsupported silicone rubber insulating tapes has been introduced by Continental-Diamond Fibre Corp., Newark, Del.

Chief advantage of the new tapes, called Level-Wrap, is their triangu-



***Insulating tape** has a triangular cross section, permitting it to be wrapped on irregular shapes.*

now! get this NEW problem-solving money-saving Setko Catalog 23 FREE



- Includes new self-locking set screw selector chart.
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- Complete information on cost-cutting Setko hopper feed method of inserting set screws.

Lists all standard set screw and socket screw products... plus many special types designed for unusual conditions of vibration; close precision setting; resistance to tampering, etc. Describes many specific ways in which Setko Set and Socket Screw products cut costs, improve product quality.

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.... Sleeve Bearing Materials
.... Sheet Formed Plastics Parts
.... How to Select a Stainless Steel
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.... Filament-Wound Reinforced Plastics
.... Ferrous Castings
.... Automobiles: What Materials Are Next?
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.... Guide to Materials Standards & Specifications—PRICE 75¢

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What's new IN MATERIALS

lar cross sections, which permit them to be wound on irregular shapes. The developer says each tape is as thick at its apex as the required total insulation thickness. When wrapped in overlapping halves, the tapes give smooth, even external surfaces. A colored center line guides the wrapping and overlapping.

The new tapes are said to have good thermal stability, good corona and moisture resistance, high resiliency and good thermal conductivity.

They are supplied in eight standard grades ranging from 1 to 1½ in. in width, and from 0.020 to 0.080 in. in thickness at the apex and 0.007 to 0.008 in. in thickness at the edges.

KEY NO. 607

TFE-Coated Wire Cloth

Cambridge Wire Cloth Co., Cambridge, Md. is marketing TFE-coated wire cloth. The coating is applied evenly over the entire surface of the cloth and does not interfere with mesh openings in sizes as fine as 180 per in.

A typical application for the material is in liquid filtering operations where water is present: the TFE coating holds the water back and permits other liquids to pass through.

KEY NO. 608

Low Carbon Die Steel Sold in Two Grades

A new die steel has been introduced by Heppenstall Co., 4620 Hatfield St., Pittsburgh 1. It is a low carbon, high molybdenum, high nickel, precipitation-hardening type of steel called Grade 5M21.

The alloy is supplied in two grades: Prestem (prehardened) and Presneal (annealed).

The new material is recommended for press dies, upsetter dies, insert dies, die casting dies, piercers, punches and centrifugal casting dies.

Prestem—The as-quenched hardness of Prestem increases with the application of heat either by tempering or by the transfer of heat from hot metal being worked. The material can be hardened at 950-1050 F with-

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many who may find it useful to review fundamentals from time to time.

Determining the Depth-Hardness of Alloy Steels

The hardenability of an alloy steel is usually measured by the depth to which the steel will harden under specific conditions of heating and cooling. One of the most conclusive methods of determining depth hardness is the end-quench hardenability test (ASTM A255). In essence, this test is as follows:

A 1-in. round specimen, approximately 4 in. long, is heated uniformly to the proper quenching temperature. The specimen is removed from the furnace and placed in a bracket; then a jet of water at room temperature is played on the bottom face of the specimen without touching the sides. This water jet is kept active until the entire specimen has cooled. Longitudinal flat areas are ground on opposite sides of the piece, and Rockwell C readings are taken at 1/16-in. intervals. The resulting data are plotted on graph paper, with the Rockwell C values as ordinates and distances from the quenched end as abscissae.

Experiments have shown that the points on the hardenability curve approximate the cooling rates at the centers of quenched rounds of various sizes; and that the hardness values at the centers of these rounds will correspond very closely with those shown at points on the end-quench hardenability curve.

In general it may be said that when end-quench curves for different steels approximately coincide, these steels can be treated similarly for equivalent tensile properties in sections of the same size.

A study of hardenability curves reveals that depth-hardness depends upon the amount of carbon present, the alloy content, and the grain size. Manganese, chromium, and molybdenum are the chief elements that promote depth-hardness, while nickel and silicon help to a lesser degree. It should be noted, also, that phosphorus promotes depth-hardness, while sulphur has a negative effect. In normal low-phosphorus and low-sulphur steels, the two elements neutralize each other.

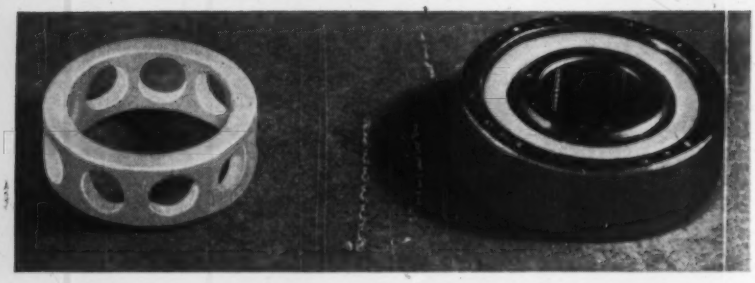
This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

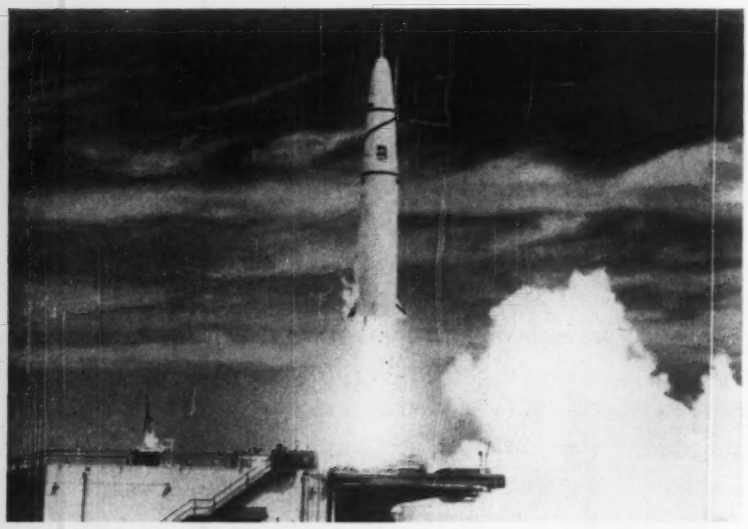
BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 334



Oil-filled **NYLASINT**® retainer helps keep missiles on target



Ball bearing retainers of oil-filled, micro-porous Nylasint have unique resistance to bleeding under extremes of temperature, pressure and acceleration. Leading builders of inertial guidance systems are taking advantage of Nylasint's unique oil-holding characteristics for improved lubrication and performance of gyro rotor bearings. Nylasint retainers prevent navigational errors induced by even the slightest shifting of oil masses.

Sintered from finely divided nylon powder and impregnated with oil, Nylasint parts retain up to 50% (by weight) of the lubricant to minimize friction in bearing and wear applications. Almost 20% of the initial oil is retained at accelerations of 15,000 G's.

Inorganic additives also give resilient Nylasint parts outstanding dimensional stability, high load capacity, and increased wear resistance.

For complete technical data on Nylasint, and its design possibilities, write for new Nylasint Bulletin.

POLYPENCO® *industrial plastics*

Halex Corporation
a subsidiary of
The Polymer Corporation
Reading, Pa.

For more information, turn to Reader Service card, circle No. 373

COMPOSITION OF 5M21 (%)

Carbon	0.18-0.23
Silicon	0.20-0.35
Nickel	3.00-3.25
Manganese	0.63-0.78
Molybdenum	3.25-3.50
Chromium	0.15 max

out the hazards of cracking, scaling, decarburization, distortion or warpage. It can also be safely water cooled in service. Prestem is supplied in Rockwell hardnesses of C36-40 and C41-45.

Presneal — This grade provides greater ease in machining hot work dies and tools when the low carbon steel is heat treated beyond the standard hardness range of Prestem (C41-45). **KEY NO. 609**

Epoxy Laminates For Printed Circuits

Three new epoxy-base laminates have been introduced for printed circuit applications.

1. Epoxy-paper laminate

A self-extinguishing, epoxy-paper laminate for printed circuit applications has been announced by General Electric Co., Laminated Products Dept., Coshocton, Ohio. Designated No. 11577, the laminate is said to have excellent cold punching and machining characteristics, high insulation resistance, and good electrical properties.

The new laminate has 1 million megohms resistance at 95 F, and twice the impact and flexural strengths of XXXP standards, according to GE.

The material is designed to withstand cyanide plating solutions and to provide improved bonding between copper and laminate for increased circuit reliability.

It is available in standard sheet sizes of 36 by 36 in. and 36 by 72 in., in thicknesses from 0.031 to 0.250 in. **KEY NO. 610**

2. Epoxy-glass laminates

Micaply Grade EG-761-T is the name of a new epoxy-glass laminate designed for etched circuitry.

The developer, Mica Corp., 4031 Elenda St., Culver City, Calif., says

THE ONLY TOOL NEEDED

to apply

Presstite *Pressure-Sensitive* felt tape

Simplifies application most anywhere felt is used to cushion or to seal against moisture or air. Just unroll the tape and press into place with thumb or fingers. That's all. The pressure-sensitive adhesive clings tight. No need for brushes, glues, hammers or tools.

Prompt shipment DIRECT FROM MANUFACTURER . . . so you know there's a supply ready for shipment in the type and width you want.

Three Types:

- No. 500 FELT—Untreated top quality felt with pressure-sensitive adhesive.
- No. 505 FELT—Specially treated felt with pressure-sensitive adhesive designed to hold in place during assembly.
- No. 508 FELT—Wax-impregnated, chromate treated felt with pressure-sensitive adhesive designed to hold in place during assembly.

For data, prices, and samples write Dept. I-23. Also, see our catalog of sealants in Sweets' Design File.

PRESSTITE SEALING COMPOUNDS

PRESSTITE DIVISION
AMERICAN-MARIETTA COMPANY

A-M

3756 CHOUTEAU AVE. • ST. LOUIS 10, MO.

For more information, turn to Reader Service card, circle No. 415

From New York to Los Angeles and back—3½ times!

annual production capacity of ultra-thin metal strip now totals 96 million feet

Production capacity of ultra-thin metal strip and foil at Precision Metals Division of Hamilton Watch Company today is unmatched by any other plant in the world. This unique metals processing plant is now capable of an estimated annual volume of more than 18,000 miles of ⅛″ x .000125″ strip.

thicknesses from .100" to .0001" Hamilton precision strip and foil is available in virtually any alloy cold rolled in a thickness range from .100″ to ultra-thin .0001″ in widths up to 10″. Precise control of metallurgical and physical properties is maintained at all times.

comprehensive metallurgical facilities The Precision Metals Division is a completely integrated metals processing plant with facilities available for development and production. Special alloys to your own specifications can also be furnished in the form you require. For information write today for Facilities Booklet DE-12 and Technical Data Sheets on such metals as Stainless Steel, Magnetic Alloys, Alfenol, Havar and Elinvar Extra.

HAMILTON

WATCH COMPANY / **Precision Metals Division**

Lancaster, Pennsylvania

Representatives
COREY STEEL COMPANY • Chicago, Illinois
FAGERSTA STEELS PACIFIC, INC • Los Angeles, California

For more information, turn to Reader Service card, circle No. 374

the important feature of the material is the absence of any fabric weave pattern through the copper surface, providing a smooth finish that makes durable electroplated circuits easy to attain. The smooth surface is also said to provide a uniform bond with the plating material and, consequently, greater consistency in electrical values through the circuit.

According to the producer, Grade EG-761-T meets or exceeds the requirements of military specification MIL-P-18177D, Type GEE.

KEY NO. 611

Grade FR-4 is the name given to a flame retardant epoxy-glass laminate introduced recently by Synthane Corp., Oaks, Pa. It is recommended for printed circuit applications.

The new laminate is said to have good mechanical strength at room temperature, and good dielectric loss and dielectric breakdown properties under both dry and humid conditions. It meets mechanical and electrical requirements set forth in military specification MIL-P-18177D, Type GEE. The laminate is supplied in sheets, rod and tubes.

KEY NO. 612

Two New Metal Tubes Have High Strength

Two new types of metal tubing are said to have higher strength than presently available tubing designed for similar applications. One type is steel and is designed for use in the petroleum industry. The other is copper and is designed for use in heat exchangers, missiles and aircraft, and chemical processing equipment.

1. Steel tubing

The steel tubing was developed by National Tube Div., United States Steel Corp., 525 Wm. Penn Pl., Pitts-

AWARDS COMPETITION — Entries for the 5th annual Awards Competition for the Best Use of Engineering Materials are due Feb 1, 1961. See pp 113-116 for details.

Why "do-it-yourself" fabrication seldom pays

This is a "long length" saw, especially built to cut sheets of Synthane laminated plastics of over 25 feet in length.

It is extremely improbable that you would ever have sufficient work to make the purchase of such a machine profitable. Yet the long length saw is only one of hundreds of unusual machines necessary for fast, accurate, economical fabrication of laminates.

Without the advantage of special machines and tools, and faced with the possibility of errors, waste, delays, mistakes in tolerances or dimensions —at your expense—you may come to the same conclusion as have nearly all of our customers—buy your laminated plastics from us and have us fabricate them for you. Call any of our representatives—located in all principal cities—for a quotation or write to Synthane Corporation, 3 River Road, Oaks, Pa.

You furnish the print—we'll furnish the part

SYNTHANE
CORPORATION OAKS, PENNA.
Sheets • Rods • Tubes • Fabricated Parts
Molded-laminated • Molded-macerated

For more information, turn to Reader Service card, circle No. 436

Morganite PY7 Seals provide high reliability in this missile application where premium performance is essential due to severe environmental conditions. Combustion gases at 900°F are on one side, oil at low temperature on the other. Speed is 3600 R.P.M., face load 20 lbs. and mating surface is stainless steel.

Specify Morganite for all seal requirements. Ask Morganite engineers for a recommendation on your specific applications. Morganite seals assure longer life in the presence of grease, searching liquids, corrosives, high pressures and high temperatures. Call or write for complete data, today — please address inquiries on company letterhead.

FOR OVER HALF A CENTURY...

Morganite INCORPORATED

TRADE MARK

Manufacturers of Fine Carbon Graphite Products including Mechanical Carbons, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts — Distributors of 99.7% Pure Al_2O_3 Tubes, Crucibles and Crusilite Electric Heating Elements.

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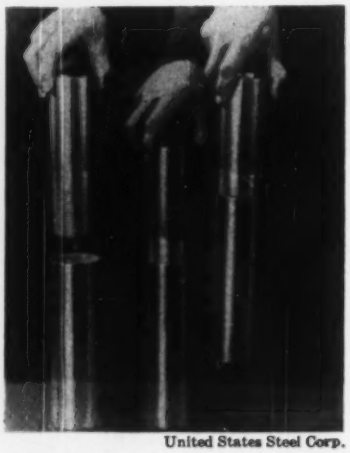


United States Steel Corp.

***Steel tubing** is firmly placed in coupling (center) to demonstrate its excellent stabbing characteristics. Without turning either piece, the coupling was lifted from table (right).*

burgh 30. Key to the tubing's high strength is a new buttress-thread design. The developer says inherent support in the thread makes the joint at least 98% as strong as the tube body without increasing tube wall thickness. Previously, tube ends had to be upset and made thicker in order to have the joint strength equal to the tube body strength. This took up valuable space and reduced clearances for a casing placed inside the tubing.

National Tube says the new tubing design provides a highly efficient, economical joint that allows greater clearances between tubing and casing. Thus tubing and casing slip together easily on normal impact. This feature is said to permit faster make-up and to lessen the possibility of cross threading and thread damage. Tests show the tubing withstands at least 12 repeated make-ups and breaks without galling.

The buttress threads are tin plated to assure protection against leakage and to withstand pressures up to 15,000 psi. KEY NO. 613

2. Copper tubing

High frequency resistance welding, described in the Jan '60 issue of this magazine (p 110), is being used by Tubotron, Inc., 654 3rd St., Newark, N. J. to produce a new line of

3M COMPANY CHEMICALS THE RAW MATERIALS OF PROGRESS

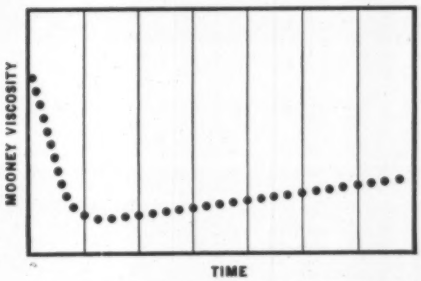
NEW FLUOREL® 2141

BRAND ELASTOMER

Its Mooney Scorch Rating is ideal for the fluorinated rubber processor because it makes possible fast, more economical cures with fewer defects, less scrap, fewer rejected parts. Material can be reprocessed with greater safety.

A SIGNIFICANT BREAKTHROUGH in elastomer processing has been made possible by 3M research through development of its new FLUOREL 2141 Elastomer.

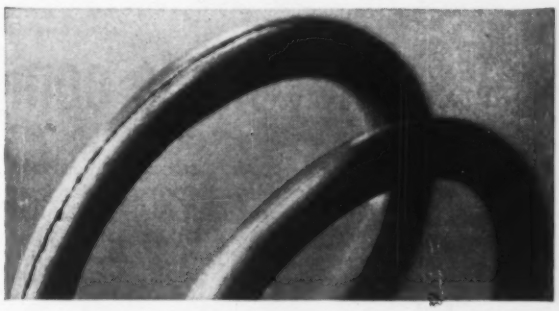
This remarkable new product has a Mooney Scorch Rating outstanding among fluorinated elastomers. The range permits the rubber processor to achieve fast, more economical cures with fewer defects, less scrap and fewer rejected parts. The inherent safety of FLUOREL Elastomer 2141 allows repeated reprocessing to produce high quality parts that meet military specifications or other critical end uses.



MOONEY SCORCH CURVE for FLUOREL 2141 Brand Elastomer.

At the same time, the outstanding physical qualities of the elastomer are retained. They include: non-combustibility, excellent resistance to corrosive chemicals, fuels, solvents and ozone, minimum compression set, rated for continuous service at 400° F., and the ability to tolerate 600° F. temperatures for reduced periods under certain service conditions.

If you use or work with elastomeric materials, it will pay you to examine the remarkable features of this new product. Examine, too, your present rubber products with an eye toward increasing their life and quality through use of FLUOREL 2141 Elastomer. For complete data, write today on your company letterhead to: 3M Chemical Division, Dept. KAR-120, St. Paul 6, Minnesota.



FLUOREL 2141 "O" ring, bottom. Note freedom from defects because of the improved scorch characteristics of FLUOREL Elastomer "O" ring as opposed to elastomer at top of photograph.

"FLUOREL" is a reg. T.M. of 3M Co.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

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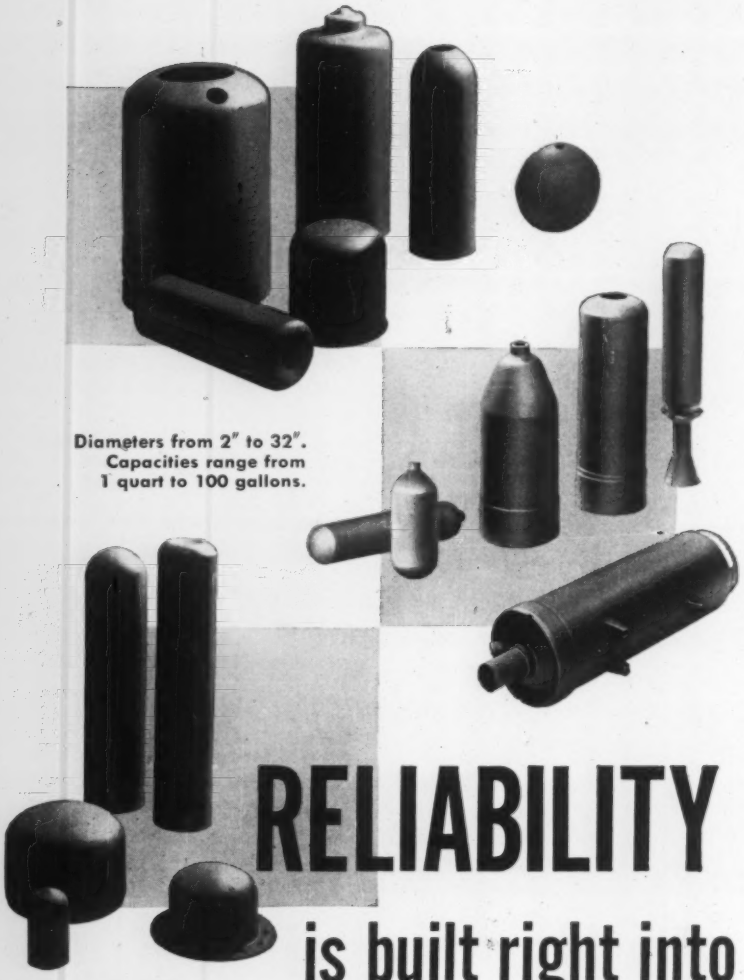


RELIABILITY
is built right into
Hackney-made components

Hackney forming methods produce strong, lightweight, seamless shells the cold drawn way. With smooth, clean surfaces, consistently uniform side walls and closely controlled tolerances, performance reliability becomes an integral part of every Hackney deep drawn shape or shell.

You will find plenty of design latitude in our methods because we make available to you a vast assortment of dies, mandrels and related tooling to match your ideas. Units can be made in sizes from 1 qt. to 100 gal. Diameters range from 2" to 32". Lengths may be from ½ to 5 times the diameter, or up to 110"... working pressures to 10,000 psi, depending on diameter.

Hackney experience and facilities can form your components in steel, magnesium, nickel, ultra-high-strength stainless steels, hot work tool steels, molybdenum or titanium. Let our engineers help you work out details and suggest ways to improve reliability... reduce cost. For complete information, write to the address below:

Pressed Steel Tank Company

Manufacturer of Hackney Products Since 1902

1442 South 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

For more information, turn to Reader Service card, circle No. 414

high strength copper tubing.

According to the producer, the welded tubing withstands more than 2000 psi hydrostatic pressure. This value is said to be twice as high as the maximum test pressure values given in ASTM specifications for all types of copper tubing.

The new line of tubing is supplied in outside diameters from ½ to 3½ in., in wall thicknesses from 0.017 to 0.140 in., and in lengths up to 25 ft.

KEY NO. 614

New Type of Glass Has Low Radioactivity

A new type of glass with low radioactivity has been developed by Corning Glass Works, Corning, N.Y.

The glass is said to have a radioactivity of less than 10 counts/min/kg: most glasses in present use have a count of more than 175. Composition of the new glass has not been revealed.

Corning says the glass will be used to make bulbs, headers and other parts of photomultiplier tubes, a vital part of radiation measuring equipment. The glass will be offered in the form of bulbs and tubing in early 1961. KEY NO. 615

Solid Film Lubricants Increase Tool Life

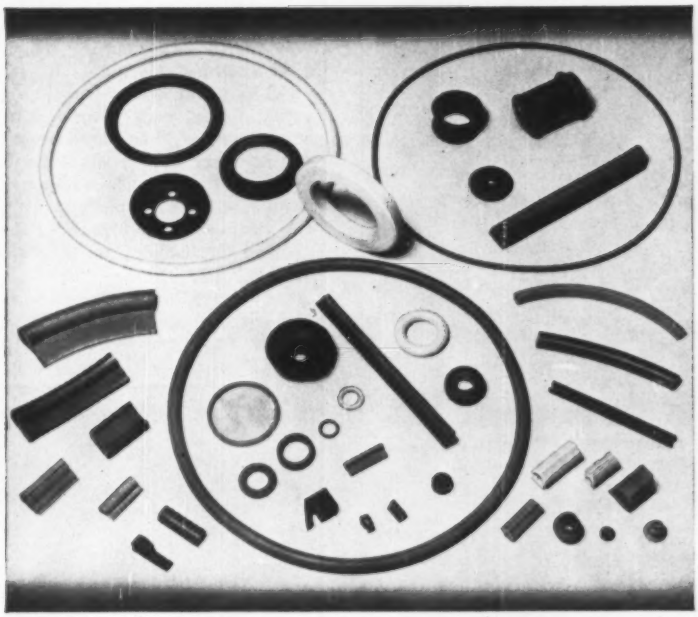
Longer lasting tools for metal cutting, spinning, stamping and drawing operations are promised with the introduction of two new solid film lubricants.

1. Lubricant for spinning

Electrofilm, Inc., 7116 Laurel Canyon Blvd., North Hollywood, Calif. is marketing a solid film lubricant designed for metal spinning, die stamping and forming, tube bending and wire drawing. According to the producer, friction temperature of unheated spinning parts drops from 125-155 F to 85-105 F when the lubricant is substituted for colloidal graphite lubricants.

The lubricant, called 22-T, is easily applied to tools, and can be washed off finished parts in warm

RUBBER
in Design
Engineering



FITTING THE MATERIAL TO THE APPLICATION

No two rubbers are alike. Be sure that, when you design a rubber part, you specify precisely the type of rubber needed for the job involved. Garlock will be glad to offer help, having had years of experience in the engineering and production of molded and extruded, die-cut, and metal bonded parts:

Natural Rubber—used where high tensile strength and resiliency are required. Good air-aging properties. Resists dilute aqueous solutions. Applications include automotive air springs, shock mounts, tubing.

Styrene Butadiene Rubber—used where resistance to aging is important. Good abrasion, water resistance. Readily available, low cost. Applications include weather stripping, pipe joint gaskets, bushings and grommets.

Nitrile Rubber—extremely good oil and gas resistance . . . low solubility, low swelling, good tensile strength, excellent abrasion resistance. Used up to +250° F as oil seals, "O" Ring packing, oil resistant parts.

Neoprene Rubber—relatively unaffected by oxidation, weathering, ozone, sunlight, chemicals. Good resistance to abrasion, cutting, chipping. Applications include bridge pads, flexible couplings, spark plug boots.

Butyl Rubber—outstanding impermeability to gases, excellent dielectric properties, good resistance to tearing after aging. Unaffected by weather, ozone. Used as hydraulic seals, vibration mountings.

Garlock also offers a complete line of specialty rubbers to resist the higher temperatures and more reactive fluids introduced by modern industry and the jet age.

GARLOCK

Further information may be obtained from your Garlock representative at the nearest of Garlock's 26 sales offices throughout the U.S. and Canada. Or, write for Catalog AD-167, Garlock Inc., Palmyra, N. Y.

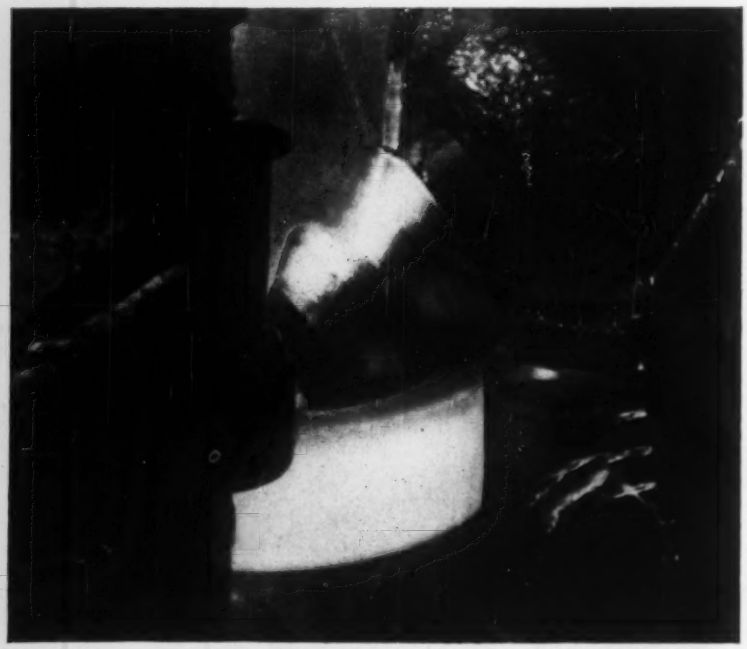
Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded & Extruded Rubber, Plastic Products

For more information, turn to Reader Service card, circle No. 362

rolls your ring troubles away—



Closeup of ring rolling, showing edging roll and portion of ring.

Edgewater ROLLED STEEL Rings

Your choice of diameter and cross-section —Complete, modern rolling, heat-treating and machining facilities enable us to produce steel rings *with precise accuracy* . . . in a large range of sizes and wide variety of cross-section shapes. Sizes are from 5 in. to 145 in. in diameter; shapes may be simple or complex. Edgewater rolling process minimizes finishing operations . . . provides rings of maximum strength, toughness and uniformity.

Meeting your specifications— Send us your drawings. We can furnish rings to closest tolerances or recommend revisions that will give you the best combination of performance and economy.

Edgewater Steel Company

P. O. Box 478, Dept. MDE Pittsburgh 30, Pa.

For more information, turn to Reader Service card, circle No. 356

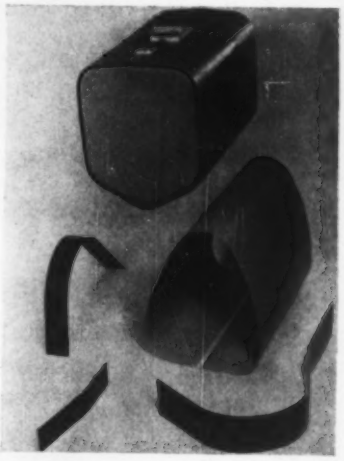
water. It is especially useful on stainless steel, aluminum, titanium and cold rolled steel. Composition has not been disclosed. **KEY NO. 616**

2. Lubricant for cutting

Molykote PVE is the name given to a new solid film lubricant introduced recently by Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn. The producer says Molykote PVE has increased cutting tool life by as much as 300%.

The lubricant is easy to apply and is said to be more wear resistant than phosphate and resin-bonded type coatings. It requires neither chemical nor mechanical surface pretreatments such as phosphating or sandblasting. The lubricant dries in 5 hr at room temperature to a tough, thin film.

The lubricant is a two-part system: one package contains a dispersion of fine particle-size molybde-



Curved fiberglass panels—Flat fiberglass panels are being formed into the curved shapes shown above by a new process developed by Molded Fiber Glass Sheet Co., 4401 Benefit Ave., Ashtabula, Ohio. Details as to how the method works have not been revealed. The developer says panels in any wall thickness can be permanently formed into a variety of shapes. The company is using the process for some proprietary products and is also making it available for custom work. Typical parts that have been made include machine housings, containers and tanks.

KEY NO. 617

Baskets cast of HT high-nickel alloy give outstanding performance at 1700° F

These baskets carry metal parts through a malleabilizing cycle of 45 to 50 hours at 1600-1700° F.

They're cast of Type HT* nickel-chromium-iron alloy to obtain excellent strength and ductility. These properties, combined with this high-nickel alloy's outstanding resistance to oxidizing atmospheres, result in long service life and dollar-saving economies.

Type HT high-nickel alloy, with its heat resistance and good strength—with its casting ease and economy—proves time and time again to be an ideal choice for furnace baskets, trays and other load-bearing members used in heat treating furnaces.

Wide range of alloys. Type HT alloy is just one of a family of five austenitic casting alloys available for heat treating service. Each—thanks to its high alloy content—provides outstanding resistance to thermal fatigue and most furnace atmospheres.

In this family of high-nickel alloys, you'll find metals that provide good strength and long life at temperatures from 1200 to 2300° F. You'll find alloys with remarkable combinations of properties—properties needed to withstand oxidizing and reducing environments and carburizing and nitriding atmospheres.

Which heat-resisting alloy is best for your needs? You'll find the answer in the 72-page booklet, "Heat Resistant Castings, Corrosion Resistant Castings ... Their Engineering Properties and Applications." Write Inco for your copy today.

*A.C.I. designation.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

For more information, turn to Reader Service card, circle No. 381

Boeing Airplane Company Photo

NOW, PLUG-IN VERSATILITY WITH ANY TINIUS OLSEN UTM

Take a closer look at the Portable XY Strip Chart Recorder in the right foreground. This versatile recording unit can be plugged into any one of the Tinius Olsen Electmatics equipped with suitable adapters in the quality control mechanical test laboratory at Boeing Airplane Company, Seattle. Result —the inherent flexibility of a *single* XY Strip Chart Recorder can be employed when and where needed without a major investment in specialized testing machines. As desired, a series of tension, compression or various types of cycling tests can be recorded in rapid succession on the same chart, or tests made using an extended time base. In a matter of seconds, a general laboratory machine can be converted into a specialized research testing tool.

The unique utility of a plug-in XY Strip Chart Recorder is available for any Tinius Olsen Electmatic or Super "L" UTM — new or installed regardless of capacity. Here is further proof that you get more for your testing machine dollar from Tinius Olsen.

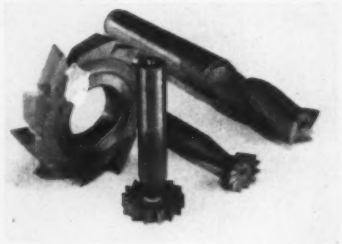
Write today for information.

Trademark Reg. U.S. Pat. Off.

TINIUS OLSEN
TESTING MACHINE COMPANY
2010 EASTON ROAD • WILLOW GROVE, PA.
Testing and Balancing Machines

For more information, turn to Reader Service card, circle No. 407

What's new IN MATERIALS



Alpha-Molykote Corp.

New lubricant *is said to give a smooth, continuous surface on steel cutting tools such as those shown in the photo above.*

num disulfide powder in paste form; the other package contains reactive components in liquid form. The two parts are mixed and used in a conventional paint spray gun. The developer says shelf life of the mixture is about one day.

The new lubricant can be used over the temperature range —300 to 600 F. It is unaffected by normal lubricating oils, solvents, cutting fluids and highly compounded gear oils. It is not designed for corrosion protection. After coating cutting tools, it is suggested that they be covered with a strippable plastics coating. **KEY NO. 618**

Electrodes for Welding Aluminum, Alloy Steel

Two new welding electrodes have been introduced recently. Both electrodes can be used in all positions, including flat, vertical and horizontal. One electrode is designed for use on low alloy steels and the other for aluminum.

1. Electrode for steel

The low alloy welding electrode has been added to a line of electrodes available from Metal & Thermit Corp., Rahway, N. J. Called Murex Type 1013, it is designed for use on low alloy, high strength steels. It is particularly well suited for single-pass welds on SAE 4130 and other types of alloy steels where high strength is desired after heat treatment. The producer says preheating is not necessary except in cases involving highly restrained joints.

The electrode is available in 12-in.

The seams don't show

Beautiful fit, beautiful look, beautiful soft drink dispenser. Beautiful job of close tolerance molding by General American. Working from wooden patterns, General American engineers designed six individual moldings. The shrinkage of each separate part was calculated to the thousandths of an inch. General American made the tools with the same precision.

Result—when this soft drink dispenser is assembled the seams are practically unnoticeable. In addition, the selection of the proper plastic, combined with General American's skill in molding, provides a product with very good luster, high impact properties, excellent stain resistance—and a reasonable price tag.

If you have a part or product that could or should be made of plastics, consult General American. In plastics, *it pays to plan with General American.*

in this 6-piece soft drink dispenser

GENERAL AMERICAN TRANSPORTATION CORPORATION

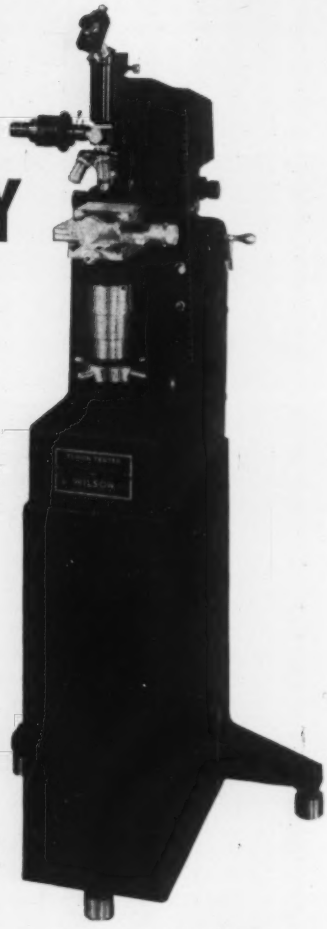
135 South LaSalle Street • Chicago 90, Illinois

Offices in principal cities

PLASTICS DIVISION GENERAL AMERICAN TRADE MARK

For more information, turn to Reader Service card, circle No. 364

the ACCURATE WAY to test MICRO and MACRO hardness



Wilson TUKON hardness tester

• Wilson TUKON testers make and measure extremely shallow indentations. They are used, for example, by manufacturers of watches, hairsprings, needles and jewels. In laboratories, TUKON instruments test individual crystals or microscopic particles. On any job, they provide these important advantages:

Accuracy—Precision-built TUKON testers give consistently correct results. Loads are applied without friction or impact—Bausch & Lomb optical equipment is standard—vibration is closely controlled.

Long life—Simple design, rugged construction make TUKON testers as durable as a machine tool.

Easy operation—Even an unskilled operator can get perfect readings after a short training period.

Supplied complete—Special accessories for various sizes and shapes.

A complete line of Wilson Rockwell instruments is available, including semi and fully automatic models.

Wilson "Brale" Diamond Penetrators Each diamond is cut to an exact shape. A comparator check and microscopic inspection of each diamond assure perfect readings every time.

Write for details—Ask for Catalog RT-58. It gives complete information on the Superficial tester as well as on the full line of Wilson Rockwell hardness testers.

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, New York

For more information, turn to Reader Service card, circle No. 450

lengths in 5/64 and 3/32-in. diameters, and in 14-in. lengths in 1/8 and 5/32-in. diameters. KEY NO. 619

2. Electrode for aluminum

All-State Welding Alloys Co., Inc., 249-55 Ferris Ave., White Plains, N. Y. is marketing the flux-coated aluminum electrode for DC reverse polarity welding of aluminum sheet, plate and castings. The electrode, called Smoothcote No. 34, is said to give dense, spatter-free deposits at low amperages. KEY NO. 620

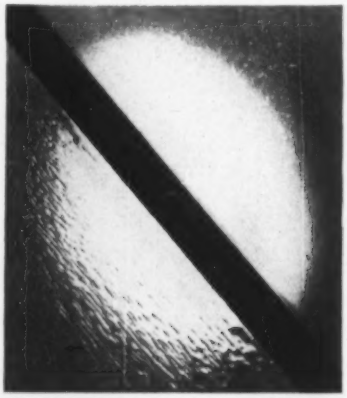
Paints Improved with New Silicone Additives

Better looking and easier-to-apply paints are said to result from the use of new silicone additives introduced recently by Dow Corning Corp., Midland, Mich.

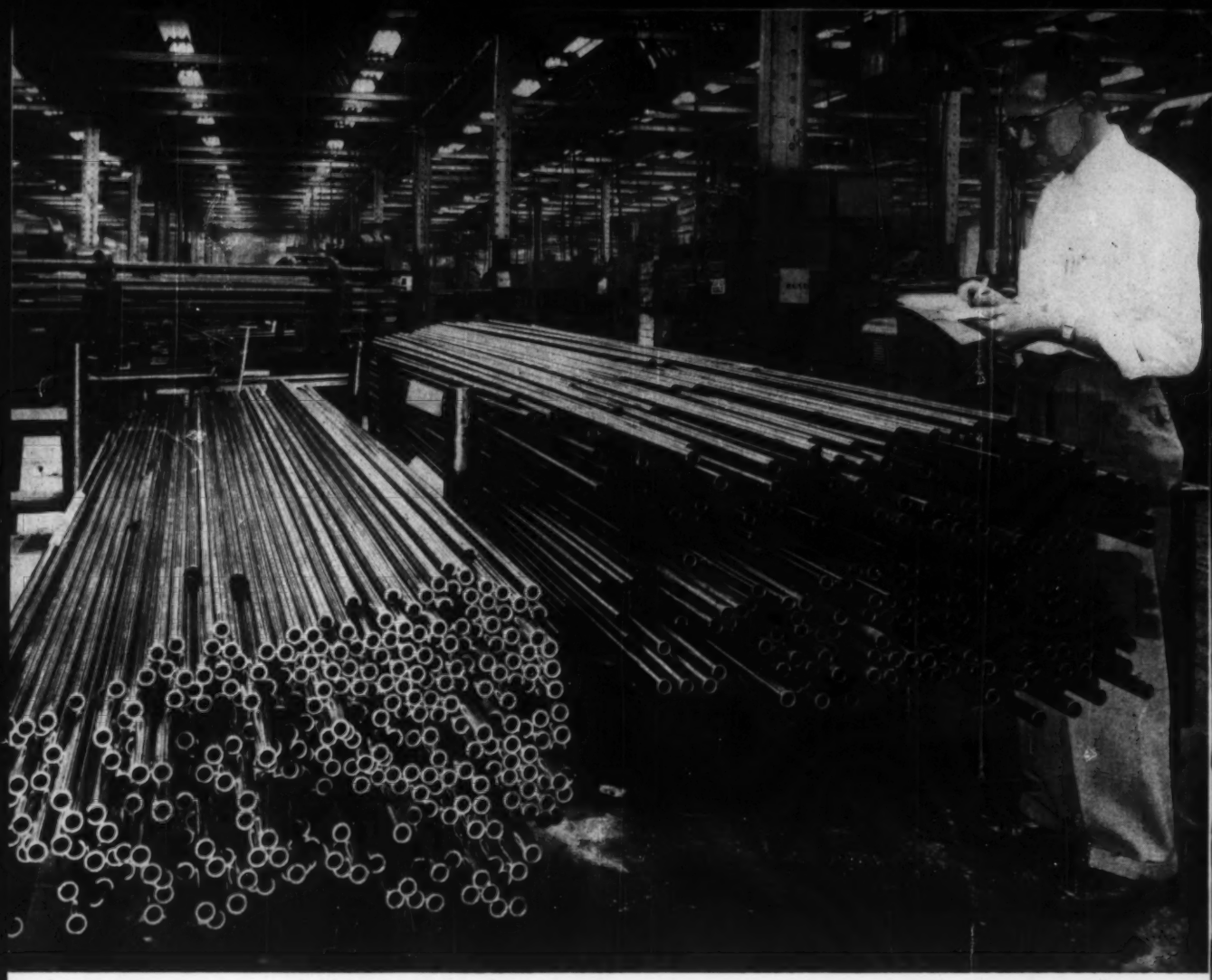
The additives, called Syl-Ad, can be used in both air-dry and oven-bake type paints. They are supplied in five different grades.

No. 1 provides maximum control over pigments, and prevents floating, flooding and silking. Paints containing small amounts of the additive can be recoated without special surface preparation.

No. 2 is similar to Syl-Ad 1 but was developed for applications in which economy is of great importance and recoatability is of no concern. *(continued on p 176)*



***Paint ridges** (left) are completely eliminated when Dow Corning's silicone additive No. 6 is added to nitrocellulose automotive lacquer.*



They make piston pins faster for less money with USS National Seamless Mechanical Tubing

It takes plenty of machine time to drill and machine the holes in 6,500,000 piston pins a year. That's what one major auto company* had to do . . . *until* the switch to USS National Seamless Steel Mechanical Tubing. By eliminating the need to drill holes in the bar stock, the company got rid of six chuckers formerly used for drilling, saved time as well as the power they consumed and the space they occupied. ☐ USS National Seamless Tubing has dimensional accuracy. It has no hard or soft spots. It's made by people who know more about seamless tubing than any other manufacturer in the world. You can choose from a complete range of sizes and steel grades. Find out how USS National Seamless Mechanical Tubing can be most effectively applied to your designs. Contact your nearest National Tube Distributor soon.

USS and National are registered trademarks

**Name supplied on request*

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York

This mark tells you a product is made of modern, dependable Steel.

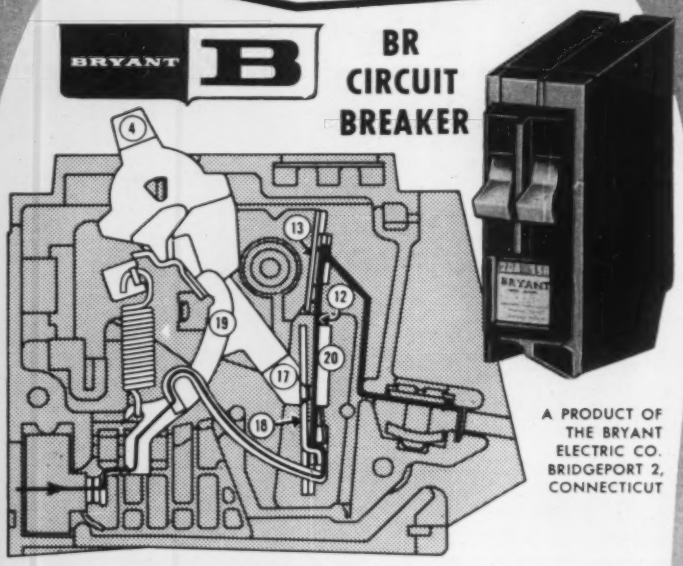
For more information, turn to Reader Service card, circle No. 401

Chace Thermostatic Bimetal

ACTUATES ANOTHER PRECISION PRODUCT

BRYANT B

BR CIRCUIT BREAKER



A PRODUCT OF THE BRYANT ELECTRIC CO. BRIDGEPORT 2, CONNECTICUT

Interchangeability, compactness and sturdiness are three features readily apparent in Bryant's BR Circuit Breaker. The ***mounting dimensions*** make it interchangeable with five other makes; there are ***two*** breakers in the space formerly used for one; the mechanism is supported and enclosed by a husky ***metal frame*** and is completely independent of the insulating case.

Not so readily apparent is the "heart" of the BR Breaker. The all-important thermal-magnetic "nerve center" includes:

Time-delay controlled by the load bimetal (12) for overload protection . . . ***overload bends free end of bimetal to right disengaging trigger (17) from armature (18) causing contact arm (19) to open.***

Second bimetal (13) of the "force balance" type, providing enclosure — ***ambient — compensation . . . as load bimetal (12) bends to right with rising ambient temperature, compensating bimetal (13) bends left, removing pressure from (12).***

Magnet (20) reacts instantly by releasing trigger (17) at about 1000% rating to limit fault current damage.

The load bimetal and the compensating bimetal are made of dependable Chace Thermostatic Bimetal. This dependability is born of two most important factors: 1. Uniformity that comes from the manufacture of precision bimetal, ***always made to specifications.*** 2. Experience. Chace has specialized in one product—***and one product only***—for more than a third of a century. Manufacturers' valuable names are safe on the outside with Chace Thermostatic Bimetal on the inside of their products.

SEND NOW FOR OUR NEW "INFORMATION BOOKLET!" It contains many well illustrated pages of general information and examples of successful applications of bimetal. 36 types of Chace Thermostatic Bimetal are available in coils, strips and completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service card, circle No. 342

No. 6 is said to simplify application of lacquers and paints by improving flow-out and leveling in dip coating applications. It is also said to reduce orange peel in spray processing.

No. 11 reduces the surface friction of coatings and gives paints more surface slip.

No. 16 is used to produce a variety of textures including hammer finishes. The additive produces a fine grain texture when added to baking and air dry enamels.

Dow Corning says the additives have proved useful in acrylic lacquers, acrylic baking enamels, alkyd melamine, long-oil soya alkyds, butyrate lacquers, polyester resins and vinyls. KEY NO. 621

Two-Part Epoxy Paste

Ren Shape is the name of a new, two-part epoxy paste that can be used as a substitute for plaster in making patterns. The material, available from Ren Plastics, Inc., 5422 S. Cedar Rd., Lansing 9, Mich., can also be used for insulating and repairing pipes, smoothing areas before painting, and patching boat hulls.

The paste is easy to mix and apply. It cures in 30 min. KEY NO. 622

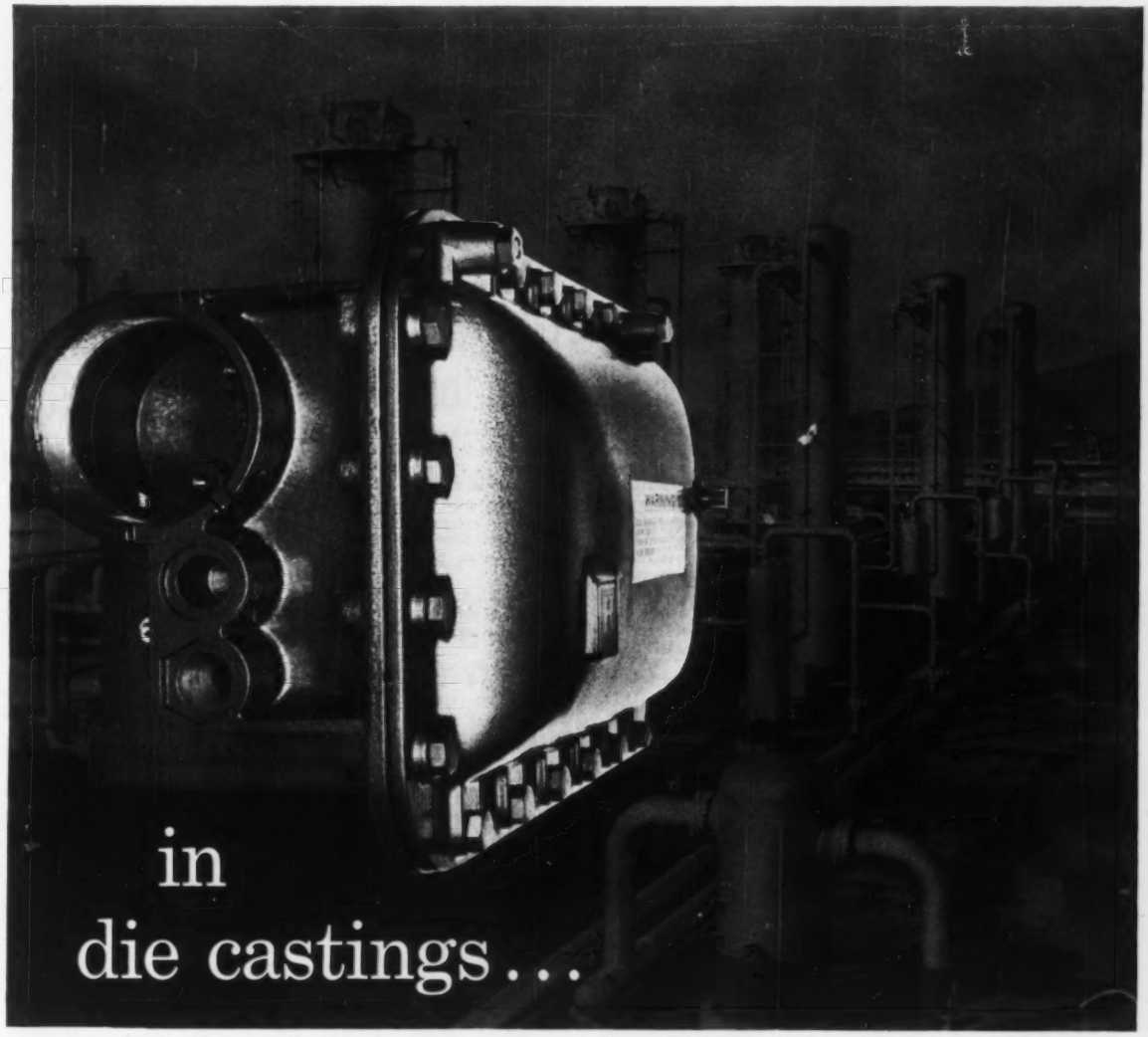
Stainless Steel Strip Is Extremely Flat

"Machined quality" stainless steel strip in widths up to 27 in. and in thicknesses up to 0.240 in. is being turned out on a new abrasive belt grinding line. The system was developed jointly by Wallingford Steel Co., Wallingford, Conn. and Behr-Manning Co., Troy, N. Y.

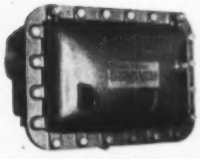
The equipment now in operation at Wallingford's plant is said to hold thickness variations across the width of stainless steel strip to less than 0.005 in.

Strip expected to be used in aircraft, missiles

A big use for the material will probably be aircraft and missile skins. Reason: the traditional crown in the center of stainless steel strip, left by all rolling methods, adds



Alcoa puts the metal where you want it



High-volume output and low cost were the twin objectives. That's why Minneapolis-Honeywell decided its new Process Pressure Transmitter must be housed in an aluminum die casting.

The housing had to be explosion-proof—for it would operate in Class 1, Group D, Division 1 locations. This called for thick walls—especially so for die casting. Mating faces had to meet flush—metal to metal—without gaskets.

These were stiff conditions—demanding a new application of the die-casting process.

Honeywell turned to Alcoa—the company with the most experience in the aluminum industry.

Working closely with Honeywell, Alcoa development engineers designed a die casting that's little short of stupendous. It's made of Alcoa's new high-strength, high-elongation casting alloy 364, which has the properties of alloy 218. Yet, the new alloy is more economical because it is easier to cast.

Hydrostatic tests proved that sand-cast prototypes withstand 500 psi, more than enough to assure that castings would withstand explosive pressures up to 125 psi. Mating faces—*as cast*—meet with an integrity that eliminates any need for a gasket.

In castings as well as forgings, impacts, extrusions and screw machine parts, Alcoa puts the metal where you want it. Learn more about Alcoa's ingenious solutions to difficult design problems—write to Aluminum Company of America, 909-M Alcoa Building, Pittsburgh 19, Pa.

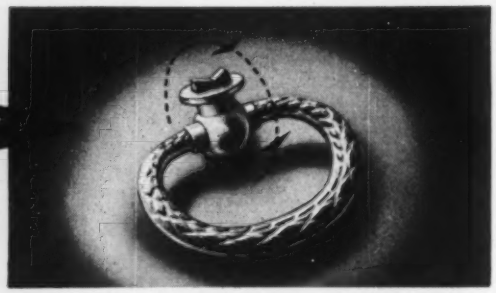
For exciting drama watch ALCOA PRESENTS every Tuesday evening, ABC-TV

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

For more information, turn to Reader Service card, circle No. 464

another unique GRC die cast zinc alloy component



this movable Intercast® element unit was

cast-assembled in one operation

by GRC

GRC's unique patented INTERCAST method die casts multiple-part zinc-alloy units with moving elements in a single, automatic, time saving, money-saving operation . . . even continuously interlocked assemblies. Units leave the machine complete . . . no trimming, no assembly, no machining needed. This INTERCAST technique is an ingenious refinement of GRC's exclusive method of small parts die casting—providing broad design latitude, close tolerances, economies in quantities of 100,000 and more.

Let GRC solve your problems. No size too small. Maximum length 1¾", maximum weight: ½ oz. ***Send TODAY for samples, prices and fact-filled bulletin.***

World's Foremost Producer of Small Die Castings

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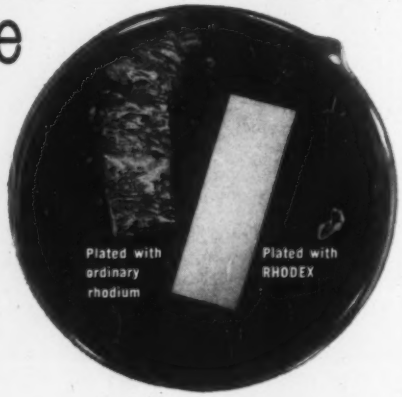
Rhodium Plate Won't Curl, Crack or Peel!



Sel-Rex® RHODEX

produces compressively stressed deposits

assuring crack-free, peel-free service. Here's proof! The photograph demonstrates the high tensile stress of conventional rhodium electroplate and the CS of RHODEX. Dissolving the basic metal caused the conventional rhodium electroplate to disintegrate into small crystalline flakes. The Sel-Rex RHODEX electroplate remained unimpaired, and in a continuous film. RHODEX does not peel or crack regardless of thickness! Write for details.

SEL-REX CORPORATION

NUTLEY 10, NEW JERSEY

Sel-Rex®

The world's largest selling precious metal electroplating processses

For more information, turn to Reader Service card, circle No. 426

costly pounds to aircraft. But Wallingford's new equipment machines off the crown, leaving an extremely flat strip.

How system works

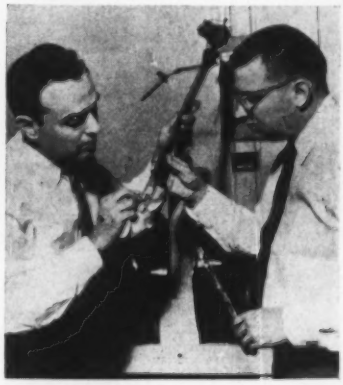
The grinding line, built by Hill Acme Co., Cleveland, consists of two vertical grinders running in tandem. The grinding medium is aluminum oxide or silicon carbide resin-bonded abrasives. The abrasive belts grind in a flood of sulfur-chlorinated oil. Stainless steel strip is put under an endwise tension of 30,000 psi and is bent sharply as it approaches and leaves the grinding point. A solid steel roll forces the strip against the grinding belts by hydraulic pressure. **KEY NO. 623**

Thermoelectric Has Improved Properties

The trend toward increasing use of thermoelectric devices for cooling and other applications may be accelerated by the development of a new material that is said to be "one of the most efficient thermoelectric materials yet developed."

The material, developed by J. H. Wernick of Bell Telephone Laboratories, 463 West St., New York 14, is composed of the elements silver, antimony and tellurium. Its chemical designation is silver antimony telluride.

The new material has a very low thermal conductivity: 0.146 Btu/hr/



***New thermoelectric** is checked by J. H. Wernick (right) and R. Wolfe of Bell Telephone Laboratories.*

NO TANGLE-NOTCH COIL

brazing rings

Snap OFF COIL

PLACE ON PART

Preformed No Tangle-Notch Coil Rings end wasted time in placing silver solder in position for brazing operations. Rings fit quickly and accurately on parts to be joined. Cut and try methods and resulting rejects are eliminated. Silver solder is actually metered to flow evenly — positive bond. Ring Diameters from ¼" to 12" — +.001. Wire Sizes .020 to .093.

Write for 16 page booklet on better brazing.

LUCAS-MILHAUPT *Engineering Co.*

5070 South Lake Drive, Cudahy, Wisconsin

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PERECO ELECTRIC TUBE FURNACE

with **KANTHAL SUPER Elements**

Operating Temperatures to 1600°C

Right: Vertically mounted KANTHAL SUPER elements develop operating temperatures to 1600°C in this Model MTKS 312 vertical tube furnace. A 3" I.D. x 30" impervious Mullite tube provides 12" long hot zone. Vertical-lift, counterbalanced loading column is manually operated. Reactor "package," strip chart recorder and controls are on separate panel.

This model MTKS-312 typifies Pereco's capabilities, based on years of specialized experience, to offer modifications of their line of standard units for operating temperatures from 450°F to 5000°F; or to design a unit specifically to solve your problem.

Write today for Pereco's recommendations to handle your laboratory, pilot plant or production furnace requirements.

Pereny Equipment Co., Inc.
Dept. A, 893 Chambers Rd.
Columbus 12, Ohio

For more information, turn to Reader Service card, circle No. 412

Engineered Ultrasonics simplifies tough cleaning jobs for Lycoming

This 2-KW **Sonogen**® ultrasonic-cleaning installation was designed in collaboration with the Lycoming Division of Avco to handle the toughest jobs in the shop. Planned originally for close-tolerance gas-turbine parts whose complex geometry and heavy scale handicapped old-fashioned cleaning methods, it now works three shifts on air diffusers (photo) and other difficult parts pre-selected for efficient **Sonogen**® cleaning. Repeated cycling in conventional cleaning baths failed to remove all scale, oxide and soil; now the fast, efficient scrubbing action of **Sonogen**® cleans every surface thoroughly without re-cycling / Your problem may be different from Lycoming's, but the solution is probably the same — a **Sonogen**® ultrasonic-cleaning system engineered for your needs. Write today, giving us full details.

Since 1946 The Respected Name in Ultrasonics

Branson

ULTRASONIC CORPORATION

17 BROWN HOUSE ROAD, STAMFORD, CONN.

For more information, turn to Reader Service card, circle No. 457

SCOTT MODEL LGP PRESSURE AGING OVEN

Featuring 14 small-volume, seamless pressure cylinders encased in a solid aluminum block . . . the Scott Model LGP sets a new standard of *safety* and *cleanliness* for pressure aging tests of rubber, silicone and other elastomers.

The Model LGP uses no liquid heating medium — no danger of oil fires or explosions, no need for costly protective barricades. Each pressure cylinder has precise-seating cap, separate purging valve, and *blowout disc* for fast, safe release of excess pressure.

No Contamination — Individual pressure stop cocks permit examination and removal of test specimen without disturbing conditions in other pressure cylinders. Positively no migration or contamination from one pressure cylinder to another! All stainless steel construction (except blowout discs) eliminates metal contamination of test material.

Easy Operation — Slight hand pressure opens or closes pressure cylinder cap. Thermo-control switch and suitable insulation assure exact, uniform temperatures. Also, has over-riding thermo-switch for double protection. Scott automatic temperature recorders are also available to guarantee conformance with ASTM Methods of Test D-572 and D-454.

Write for complete facts on Scott safety-designed Model LGP. Scott Testers, Inc., 65 Blackstone Street, Providence, Rhode Island. Tel: DExter 1-5650 (Area Code 401).

SCOTT TESTERS

THE SURE TEST . . . SCOTT!

For more information, circle No. 425

What's new IN MATERIALS

sq ft/ F/ft at room temperature. Its thermoelectric figure of merit (Z) is 1.75 x 10^{-3} per °F over the temperature range 400 to 900 F. This value is said to be the best yet observed for p-type semiconductors over the temperature range 400 to 900 F.

The materials most widely used in present-day thermoelectric devices, although inadequate for many proposed applications, are lead telluride and bismuth telluride. The search for improved materials at Bell Laboratories centered on ternary intermetallic semiconductor compounds, the best of which was silver antimony telluride.

Three Felt Tapes

Three pressure-sensitive felt tapes are designed for sound deadening, cushioning, dust and moisture sealing, and insulation.

The tapes are marketed by Presstite Div., American-Marietta Co., 39th and Chouteau Ave., St. Louis 10, Mo. One is an untreated tape called No. 500, the second is an asphalt-treated tape called No. 505, and the third is a wax-impregnated, chromate-treated tape called No. 508.

All three tapes are said to adhere to almost any clean surface and are easily applied by hand. **KEY NO. 624**

Synthetic Mica Paper Useful up to 1800 F

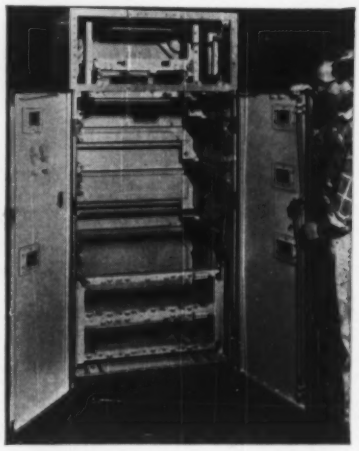
Pilot plant production of a new synthetic mica electrical insulation has been announced by Synthetic Mica Co., Div. of Mycalex Corp., 20 Passaic Ave., Caldwell Township, N. J. The material, called Synthamica 202, is designed for use at temperatures up to 1800 F.

The synthetic mica paper is expected to be used in high tempera-

PROPERTIES OF SYNTHAMICA 202

Tensile Strength, psi	5000-10,000
Dielectric Constant	3-4
Dissipation Factor	0.0005-0.0020
Dielectric Strength, v/mil	600-1000
Volume Resistivity, ohm-cm	5 x 10^{15}

Example . . .



. . . of B & P capability to make lightweight metal assemblies for electronic equipment

Designing and manufacturing products and assemblies of light metals is a highly specialized field. Techniques unknown to production in other metals must be understood and new ones must be developed for unusual requirements.

Because it has concentrated on light metal manufacturing for many years, Brooks and Perkins today has experience and capability unmatched by any other organization.

The Nike-Hercules system magnesium cabinet shown above is just one example of B & P skill in maintaining close tolerances and optimum precision. Other products and assemblies designed and produced by B & P include . . .

• cooler plates • radar reflectors • communication equipment covers • radar reflector bases • equipment housings • tripods • radar plotting equipment • shelters • transit cases • gun fire control housings and turrets

When you need lightweight products or assemblies for electronic equipment, take advantage of B & P's experience and capability.

BROOKS & PERKINS, INC.
1916 W. Fort St., Detroit 16, Mich.
Offices in Washington and New York

61-T-2

For more information, circle No. 337

Wilbow

PRECISION RUBBER PARTS SIMPLIFY SEAL DESIGN

A WILBOW Precision-Molded Shaft Seal Collar is a key factor in the remarkable performance of Bell & Gossett Booster Pumps.

This pump is the heart of the new B & G *Hydro-Flo* Heating System built into many top-quality modern homes. Its unique impeller shaft seal permits circulating oil lubrication . . . assures trouble-free, *quiet* operation. In developing this seal, Bell & Gossett engineers called on WILBOW to produce the precise molded-rubber shaft collar they needed.

WILBOW specializes in the development of molded rubber parts to meet specific design requirements and puts a full line of the newest synthetic, natural or silicone polymers at your service. Ask for our catalog to check the wide range of possibilities. Write today.

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The WILLIAMS-BOWMAN RUBBER Co.

1949 South 54th Avenue • Cicero 50, Illinois • (Chicago Suburb)

Mfrs. of molded, punched, extruded and cut rubber goods. Specialists in producing rubber covered rolls, silicone rubber parts and bonding rubber to metal

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Custom

Perforating

—on all types of flexible materials, rigid sheets, and foam.

plastics
cellophane
paper
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in sheets and rolls up to 72" wide

Whatever your perforating needs, PERFORATING INDUSTRIES has the specialized equipment and know-how to handle the job. Rely on us if you're looking for quality workmanship, prompt delivery, and fair pricing.

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TO BOND SANDWICH CORE

BETTER · FASTER · CHEAPER

USE THE NEW

METLBOND 406

today's most advanced metal-fastening adhesive system

METLBOND 406 is a large-area, one-component, low-pressure, dry, epoxy-based adhesive system. METLBOND 406 will bond similar or dissimilar metals faster, cheaper, better. No core or skin primer is required. And, since it releases no volatiles during cure, non-perforated sandwich core can be used. In airframe fabrication, drastic reductions can be made on the chances of progressive moisture condensation within wing panels or control sections. For any structural metal-joining operation, use METLBOND 406 – the "educated" adhesive. It can measurably cut your fabrication costs.

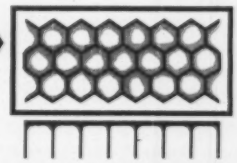
IMPORTANT CHARACTERISTICS OF METLBOND 406

Effective operating temp. range	—430F to +200F
Room temp. shear strength	5500 psi
Room temp. peel strength (in.-lbs per 3-in. width)	125

A dual-purpose adhesive system which can be used to bond metal-to-metal, or core-to-skin with equal effectiveness.

METLBOND 406 IS EASY TO USE. It can be cut, placed in position, and cured with low pressure, at moderate temperatures. Since it is a non-supported system, there is no fabric carrier. Therefore, during cure, it flows... goes where you want it!

FILLETING ACTION OF METLBOND 406



It fillets, clings, and seals off each cell wall.

NARMCO – for high-performance materials.

Formulators of: Structural and Industrial Adhesives...Reinforced-Plastic Laminating Materials ...Ablative and Molding compounds...Insulating Compounds.

NARMCO MATERIALS

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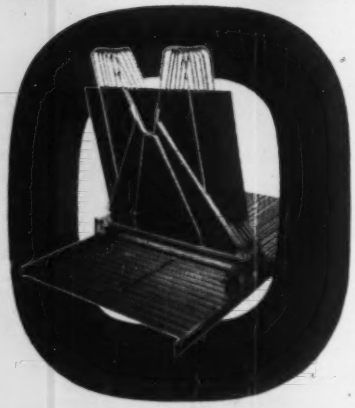
SERVES THE NATION AND INDUSTRY WITH SYSTEMS AND SUBSYSTEMS FOR CONTROLS, GUIDANCE, ELECTRONICS, TELEMETRY, DATA ANALYSIS, AND THEIR INTEGRAL COMPONENTS

For more information, turn to Reader Service card, circle No. 405

SICON® PROTECTS even in HOT OVENS



Young Brothers Co., Cleveland, a leading manufacturer of industrial ovens for the metal decorating field, uses SICON finish to protect oven wickets. Printed metal sheets are oven-dried before being formed into signs, cans, etc. As they pass through the 100 ft. oven the Sicon-coated wickets hold them in position as shown. SICON has proved most satisfactory because it keeps wickets clean, rust-free, and unaffected by temperatures in the 400° - 600°F. range. Why not try SICON on your product! Write Dept. L-1.

Sicon®
Hi-Temperature Finish by **MIDLAND**
Industrial Finishes Co.
Waukegan, Illinois

For more information, circle No. 454

What's new IN MATERIALS

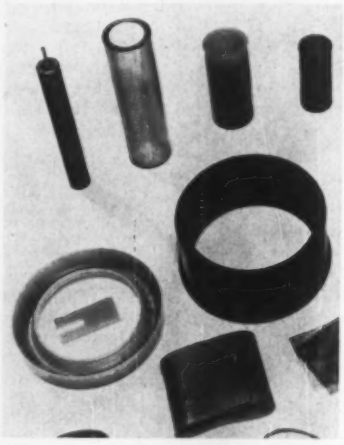
ture transformers, motors and capacitors. It is supplied in continuous strips 3 in. wide and in circular sheets up to 6 in. in dia, in thicknesses from 0.002 to 0.007 in.

The producer says Synthamica 202 is a pure mica crystallized from a melt of high purity chemicals in an electric furnace. The synthetic mica crystals are similar in structure to natural mica but have better heat resistance. **KEY NO. 625**

Process Primes, Seals Magnesium Castings

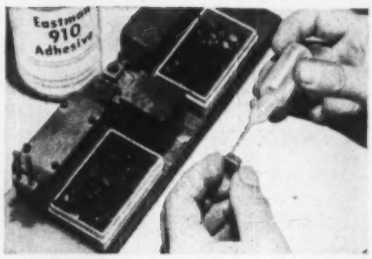
A process that combines impregnation and paint-base coating of magnesium alloy castings in a single operation has been developed by Dow Metal Products Co., Div. of Dow Chemical Co., Midland, Mich.

A magnesium casting sealed by the process is said to withstand air or



Solid urethane parts — A new family of solid urethane elastomers, available in the form of sheets, tubes, rods and cast parts, can be compounded to customer specifications for a variety of industrial and consumer applications. The developer, Armstrong Cork Co., Industrial Div., Lancaster, Pa., says that production of the urethane rubber parts is closely controlled so that such characteristics as high tensile strength and abrasion resistance can be combined with elasticity and resilience on a reproducible basis. **KEY NO. 638**

No. 20 of a series



Eastman 910 Adhesive solves another production bottleneck

Sonotone Corporation, of Elmsford, N.Y., recently introduced its new Model "66" hearing aid. An all-transistor, self-powered unit, the instrument can amplify input sound intensity 10,000 times, is no larger than a lump of sugar, weighs no more than a half-dollar.

More than 150 components are packed into this outstanding example of miniaturization.

In assembling the hearing aid, Sonotone uses fast-setting, high-strength Eastman 910 Adhesive in more than a dozen joints involving a variety of materials: plastics, rubber and metal.

A thin, clear liquid, the adhesive flows into crevices without stringing or balling, sets in seconds with contact pressure. Assembly procedures are simplified. Critical space is conserved.

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

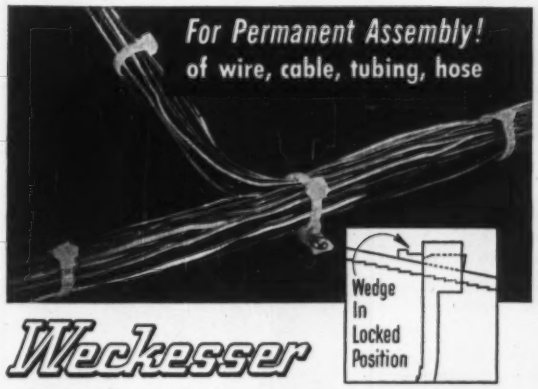
Eastman 910 Adhesive is used as it comes. No mixing, no heating. Simply spread the adhesive into a thin film between two surfaces. Light manual pressure triggers setting. With most materials strong bonds are made within minutes.

What production or design problems can this unique adhesive solve for you?

Bonds Almost Instantly with Contact Pressure
No Heat...
No Catalyst...

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9112 Dunbar Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. E-12, Kingsport, Tenn. (Not for drug use)
See Sweet's 1960 Prod. Des. File, 7/E

For more information, circle No. 354



Weckesser

WEDGE LOCK BAND CLAMP...

once locked, it's got to be *cut* loose! Really permanent! Solid nylon. One size for diameters ⅛" to 1¾".

Separate Mounting Tab

...use only where and when needed. Can be pre-mounted for simplified planning. Solid nylon.

Try them . . . write for samples, prices, full information.

Weckesser COMPANY

5713 Northwest Highway • Chicago 46, Ill.

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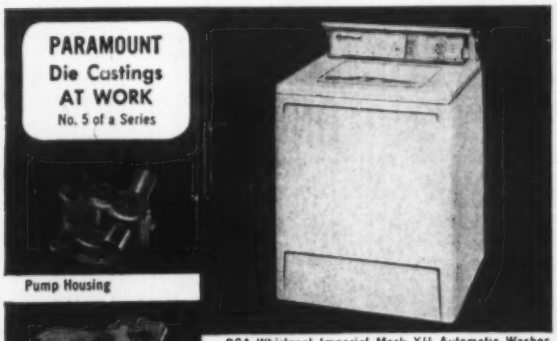
PARAMOUNT Die Castings AT WORK
No. 5 of a Series



Pump Housing

Gear Case Cover

RCA-Whirlpool Imperial Mark XII Automatic Washer

PARAMOUNT—a major supplier of die castings to Whirlpool Corporation for 15 years

Whirlpool quality is recognized throughout the world, quality which stems from the rigid quality standards which Whirlpool demands that its suppliers meet.

Paramount's engineering and production "know-how", its ability to consistently meet Whirlpool's exacting quality standards—as in these die castings for the RCA-Whirlpool Imperial Mark XII Automatic Washer—are the reasons why Paramount has consistently been one of Whirlpool's major suppliers for 15 years.

It Will Pay You To Look to Paramount . . .

If your product incorporates die castings or you're considering them—investigate Paramount's complete services.

Three complete plants—two in St. Joseph, Mich., one in Seymour, Indiana.

SEND For "Designing for Die Casting"

PARAMOUNT *Die Casting Co.*

(A subsidiary of TALON, INC.) ST. JOSEPH, MICHIGAN

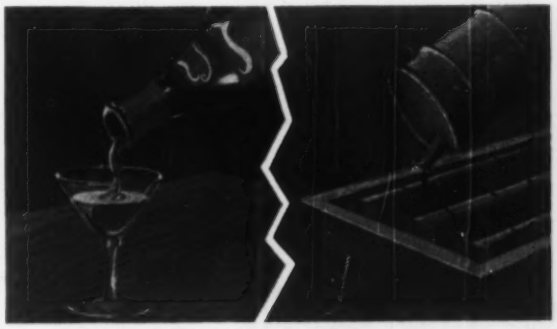
For more information, turn to Reader Service card, circle No. 410

ROHCO®

SUPPLIES THE

BRIGHT

ZINC MAKINGS



As easy to use as a cocktail mix! Just add a little ROHCO Zinc Brightener to your conventional zinc plating bath . . . and just that easy you get bright chrome-like zinc at only ½% more than the cost of ordinary zinc plating!

ROHCO 102 BARREL

For 3-D depth in a mirror-like finish. Exhibits high covering power that puts substantial thickness of deposit in recesses usually unplated. Your customer will notice the difference, too.

ROHCO 503 STILL OR BARREL

Gives jewel-like bright zinc deposits with minimum effort or expense. Ideal for large tanks or where one brightener is desired for all bright zinc baths.

With the mounting demand for bright zinc plating why not spare yourself the trouble and expense of trial and error? Why not use ROHCO Bright Zinc "makings" for consistent and dependable results? Call your ROHCO Representative, today!

ROHCO

Nationwide Stockpoints

R. O. HULL & COMPANY, INC.

1303 Parsons Court • Rocky River 16, Ohio

The RIGHT START . . . a BETTER FINISH

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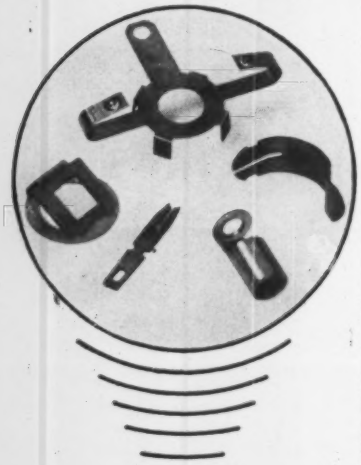
MORE BOUNCE TO THE MILLIGRAM



Somers THIN STRIP

PHOSPHOR BRONZE

From .000125" thin to .010", Somers Thinstrip phosphor bronze is produced by a unique high-speed annealing process which provides a uniform *fine grain* structure. Thus, spring temper metal is produced with elongation up to five times that of coarse grain methods, making possible the forming of much more intricate parts for many instrument and electro-mechanical applications. And Somers' close control of grain size guarantees prolonged fatigue resistance unattainable through ordinary methods.

Whatever your Thinstrip problems, in copper, copper alloys and stainless steel from .010" down and nickel and nickel alloys from .020" down, write for the Somers confidential data blank. No obligation, of course.

FOR EXACTING STANDARDS ONLY

Somers THIN STRIP

Somers Brass Company, Inc.

108 BALDWIN AVE., WATERBURY, CONN.

For more information, circle No. 430

What's new IN MATERIALS

water pressure of at least 40 psi and heating to at least 700 F. A sealed casting is also said to withstand high humidity and weathering, and to be stable in hot engine oil and kerosene.

The new process is a modification of Dow's standard anodize treatment which provides a paint base but does not seal all of the porous areas of castings. The modification consists of allowing a dwell of 20 to 30 min at constant voltage at the end of the normal anodization period.

During the dwell, anodization continues primarily in the pores of the casting, sealing minute pores effectively, according to Dow.

KEY NO. 626

Other News . . .

Metals

▸ An improved bronze weatherstrip material is being marketed by Chase Brass & Copper Co., Waterbury 20, Conn. Chase says the improved weatherstrip is free of waves and buckles, and is uniform in color from one end of a coil to the other.

KEY NO. 627

Plastics

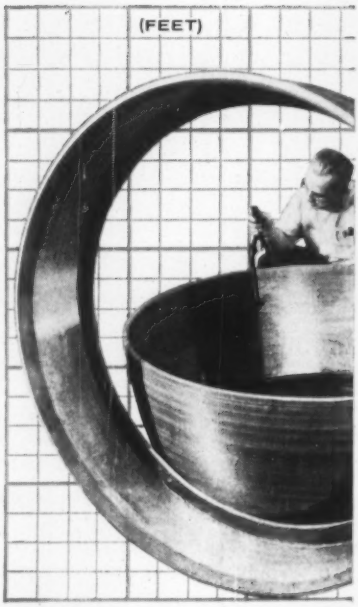
▸ Extruded polycarbonate tubing is now available from Anchor Plastics Co. Inc., 36-36 36th St., Long Island City 6, N. Y. Diameters range from 0.040 to 1½ in. and wall thicknesses from 0.015 to 0.125 in. KEY NO. 628

▸ A line of copper-clad, thin-film laminates for printed circuits is available from International Resistance Co., Plastic Products Div., 401 N. Broad St., Philadelphia 8. The company is supplying 1 or 2-oz copper bonded to Kel-F, Teflon FEP, TFE-glass cloth, polyethylene and polyester films. KEY NO. 629

▸ Bunting Brass and Bronze Co., 715 Spencer St., Toledo 1, Ohio has added nylon tubing, rods, tubular bars and plates to its line of bronze and aluminum parts. KEY NO. 630

Rubber

▸ Polysulfide rubber-base sealants are now available in a variety of colors from Products Research Co., 2919 Empire Ave., Burbank, Calif. The color hues are said to compare with recommended colors as speci-



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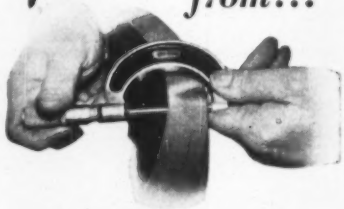

ONE INCH THICK

7075-T6 ALUMINUM PLATE FOR A SEAMLESS MISSILE SECTION

Thicknesses up to 2" and diameters up to 170" are readily PHOENIXSPUN from high strength aluminum alloys, titanium, and exotic metals. Tolerances of plus or minus .005" are accurately maintained with this radically new and exclusive, heavy duty, powerspinning equipment.

A wide range of conventional spinning requirements can also be produced economically by the various PHOENIX Metal Processing methods.

If your metal forming project involves outer space, electronic, nuclear or general industrial products contact us at once. To completely convince yourself, why not investigate the scope of our service by a personal visit to our plant?

Write for information and new brochure.

PHOENIXSPUN
METAL PROCESSING
PHOENIX PRODUCTS COMPANY
4719 North 27th Street Milwaukee 9, Wis.

For more information, circle No. 460

Now in the hands
of all subscribers . . .

1961 MATERIALS SELECTOR

The year's biggest boon to those time-pressed engineers, designers, and other technical men who select and specify engineering materials, forms and finishes! This new MATERIALS SELECTOR is more than 70 pages bigger than last year's edition.

All editorial pages in the MATERIALS SELECTOR are in data sheet form to provide you with quick comparisons of properties and applications of hundreds of metals; non-metallics; forms and shapes; and finishes and coatings. Keep the SELECTOR on your desk for ready reference. You'll find it a real time saver.

The MATERIALS SELECTOR is available to *Materials in Design Engineering* subscribers only.

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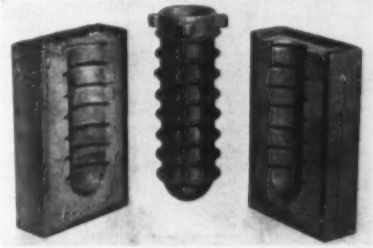
CERROTECHNICS *saves* **TIME • LABOR • MONEY**

in chucking irregular workpieces



This CERROTECHNICS application is a quick and simple method of making chuck jaws for irregular workpieces by casting CERROMATRIX® against the workpiece. The result is an accurately fitting pair of jaws.

*T.M. Cerro de Pasco Corporation

CERRO

CERROTECHNICS is the practice of using low-temperature-melting CERRO* ALLOYS to expedite many industrial operations.

Ask for further information.

CERRO DE PASCO SALES CORPORATION

312 PARK AVENUE, NEW YORK 22, N. Y.

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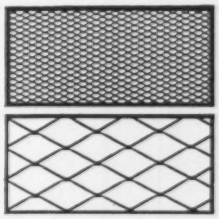
Available **NOW**

SOMETHING NEW IN EXPANDED METAL



MICROMESH

- fine mesh sizes to close tolerances
- special materials including precious metals

New MICROMESH, with carefully controlled "screen density", weight per unit area and thickness, is solving old design problems in the chemical processing, electronic and general manufacturing industries. Send for the new MICROMESH data folder and see how this new kind of expanded metal can meet *your* needs—at surprisingly low cost. Write today!

DEMCOR

DESIGNERS METAL DIVISION

of Southern Electric, Inc.

8701 S. Greenwood Ave., Chicago 19, Ill.

Manufacturers of Micromesh, Duromesh and Decromesh expanded metals

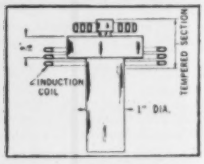
For more information, turn to Reader Service card, circle No. 349

Lepel

HIGH FREQUENCY INDUCTION HEATING UNITS

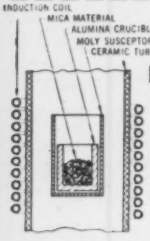
Lepel induction heating equipment represents the most advanced thought in the field of electronics... the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS



Punch Heads Selectively Tempered

Diagram shows arrangement for selectively tempering heads of alloy steel punches. The use of a combination type solenoid and pancake induction coil reduces hardness from Rc 55/56 to Rc 41/44, improving resistance to brittle fracture at the head of the punch. In this case a heating cycle of 55 seconds provides uniform tempering. A multiple position fixture, processing 4 pieces at one time, speeds up production.



Heating Non-Conducting Materials To High Temperatures

Laboratory analyses frequently require heating of non-conducting materials to temperatures of 3,000 to 3,500° F. in vacuum or special atmosphere. This can be accomplished by induction heating with the aid of a metal susceptor. Diagram shows the fusion of mica samples in an alumina crucible, using molybdenum susceptor. A ceramic tube surrounding the susceptor isolates the work for fusion in a vacuum. The molybdenum susceptor is heated by induction, which in turn, heats the crucible by radiation.

WRITE FOR NEW LEPEL CATALOG
Electronic Tube Generators from 1 Kw to 100 Kw.
Spark Gap Converters from 2 Kw to 30 Kw.

Lepel HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.

For more information, circle No. 389

fied by the Porcelain Enamel Inst. for curtain wall installations.

KEY NO. 631

▸ A line of Viton rubber molding compounds reinforced with asbestos, glass or ceramic fibers has been introduced by Rogers Corp., Rogers, Conn. The reinforced Viton rubber is supplied in the form of o-rings, seals and other molded shapes.

KEY NO. 632

Other nonmetallics

▸ A new thermoelectric material, gadolinium selenide, has been developed by Nuclear Corp. of America, Research Chemicals Div., P. O. Box 431, 170 W. Providencia Blvd., Burbank, Calif. The material is said to have excellent thermoelectric properties and good heat resistance.

KEY NO. 633

▸ A three-toned upholstery material called Tarrytown Naugaweave has been introduced by U. S. Rubber Co., Textile Div., 1230 Avenue of the Americas, New York 20. It is made in ten base colors with two contrasting tones in each. KEY NO. 634

▸ Fluoro Glide is the name of a new spray-applied dry film lubricant introduced recently by Chemplast Inc., East Newark, N. J. The lubricant is a colloidal form of TFE resin. It is recommended for lubricating the sliding parts of laboratory instruments, glass stopcocks and tapered joints. KEY NO. 635

Finishes

▸ A new plastics coating has been designed for use on metal and nonmetallic products exposed to acid and other corrosive fumes at high temperatures. The coating, called Sakaphen, is available from American Sakaphen Corp., 50 Cutter Mill Rd., Great Neck, N. Y. Composition has not been disclosed. KEY NO. 636

▸ Lehigh Chemical Co.'s Industrial Lubricants Div., Chestertown, Md. is marketing a water-base rust preventive designed especially for use on metal products that are stored indoors. The product, called Anderol L-536, can be sprayed, dipped or brushed on machine tools, molds, and dies. KEY NO. 637

INDIUM

A VERSATILE METAL

INDIUM — a high performance bearing metal — increases strength and hardness of bearing. It improves significantly resistance to corrosion by acid from lubricating oils and permits bearing surface to retain oil film better. Where high oil temperatures are encountered, it exhibits longer bearing life.

The high anti-seizure properties of lead-indium bearings make them ideal for heavy or high speed service where dependability and long life are essential. These bearings are now used in most European cars and in many aircraft and diesel engines in both Europe and North America.

INDIUM — a constituent for low melting-point alloys — Wood's metal plus 19% Indium melts at 117°F. Such alloys can be used for foundry patterns, fusible safety links and plugs and many other applications.

INDIUM — a solder material — Indium wets most metals and non-metals making it and many of its alloys a specialized solder for many applications, including glass-to-glass or glass-to-metal seals.

Cominco produces TADANAC Brand INDIUM in a variety of shapes including ingots, plates, wire and ribbon. Standard Grade Indium is 99.97% pure. Can its special qualities be of use to you? Inquiries are invited regarding the application of this versatile metal to your needs. Send for our brochure TADANAC Brand INDIUM.

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THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED
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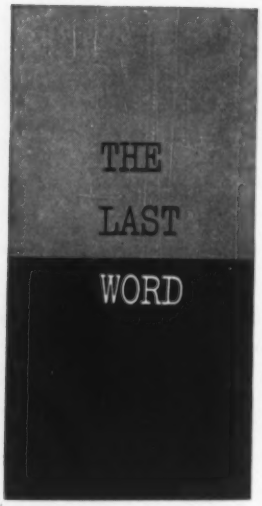
***These manufacturers advertised their products in the 1960-61 MATERIALS SELECTOR REFERENCE DATA ISSUE**

For more complete information, and application data on their lines, refer to the index of Advertisers in the Mid-November MATERIALS SELECTOR ISSUE of MATERIALS IN DESIGN ENGINEERING.

Government Puts Future of Materials in Universities' Hands



by ***H. R. Clauser***
Editor

Around the middle of this year the government's Advanced Research Projects Agency awarded unprecedented long-term contracts to three universities to undertake basic materials research. Perhaps no other single action in recent years will have a greater or more far-reaching effect on the future of the materials field. For with the issuing of these contracts, the government has given notice that it will be the major sponsor and financial supporter of basic materials research in this country for a long time to come. Also, this support is now the main hope for stimulating a much-needed increase in our supply of materials scientists and engineers.

Briefly, under the new plan the Dept. of Defense and several other government agencies will donate $20,000,000 each year to a number of universities to do fundamental research in materials. A sizable portion of the money will be used to establish interdisciplinary laboratories where graduate students and professors in physics, chemistry, metallurgy and mechanics will work together on materials problems.

This government support is needed

Few people will argue any longer that this large-scale support of fundamental materials research by the government is not necessary. To the contrary, a great many have wondered why it has taken so long for the government to make this decision.

For, as is the case in other areas such as the atomic energy field, fundamental materials research cannot be adequately supported by private enterprise. The cost is too great, and the commercial pay-off is too uncertain and too long in coming. Even industry-wide, cooperative associations must place their major emphasis on applied rather than basic research. And likewise, the universities, where basic research is supposed to flourish, have diverted many of their facilities and talents to the more lucrative business of applied research for industry.

So, it is only through substantial government support that we will be able to make significant advances in basic materials science.

Central institute idea rejected

Of no less importance than the decision to provide large-scale materials research support, was the government's decision to organize and carry out the research programs within the framework of our universities. Much thought and discussion by many qualified materials men in and out of government went into this decision. The fundamental question they faced was: how can government-financed research be performed most efficiently and with maximum freedom and minimum supervision from the government?

Some felt that the most expeditious approach would be to either expand existing government facilities or establish new federal materials research institutes. The latter has been the Russian approach, and it cannot be denied that their materials progress has been impressive. Likewise, government establishments in this country, such as the National Bureau of Standards, have an enviable record in fundamental research.

Now it's up to the universities

Nevertheless, it was the majority opinion that the institute system would not provide the best climate for independent and individual creative enterprise. As J. R. Townsend, special assistant to the director of defense research and engineering, recently put it: "We felt that the solution was to open an opportunity for various colleges or universities to put forward plans of their own for ways in which the intellectual activity on the campus, at the highest possible level, could be merged in a sort of cross-fertilization process by which chemists, physicists, nuclear physicists, mathematicians, metallurgists and others all could join forces and bring to bear their own special knowledges and academic disciplines on problems of joint concern. Graduate colleges of materials science would emerge out of the free creative talents of the college campus."

Thus, our course in basic materials research on a national level has been set. Success or failure is now largely in the laps of our universities. We are hopeful that they will succeed.

CELANESE MATERIALS REVIEW

- **FORTIFLEX linear polyolefins**
- **FORTICEL cellulose propionate**
- **ACETATE molding compounds**
- **ACETATE sheeting**
- **POLYESTER resins**

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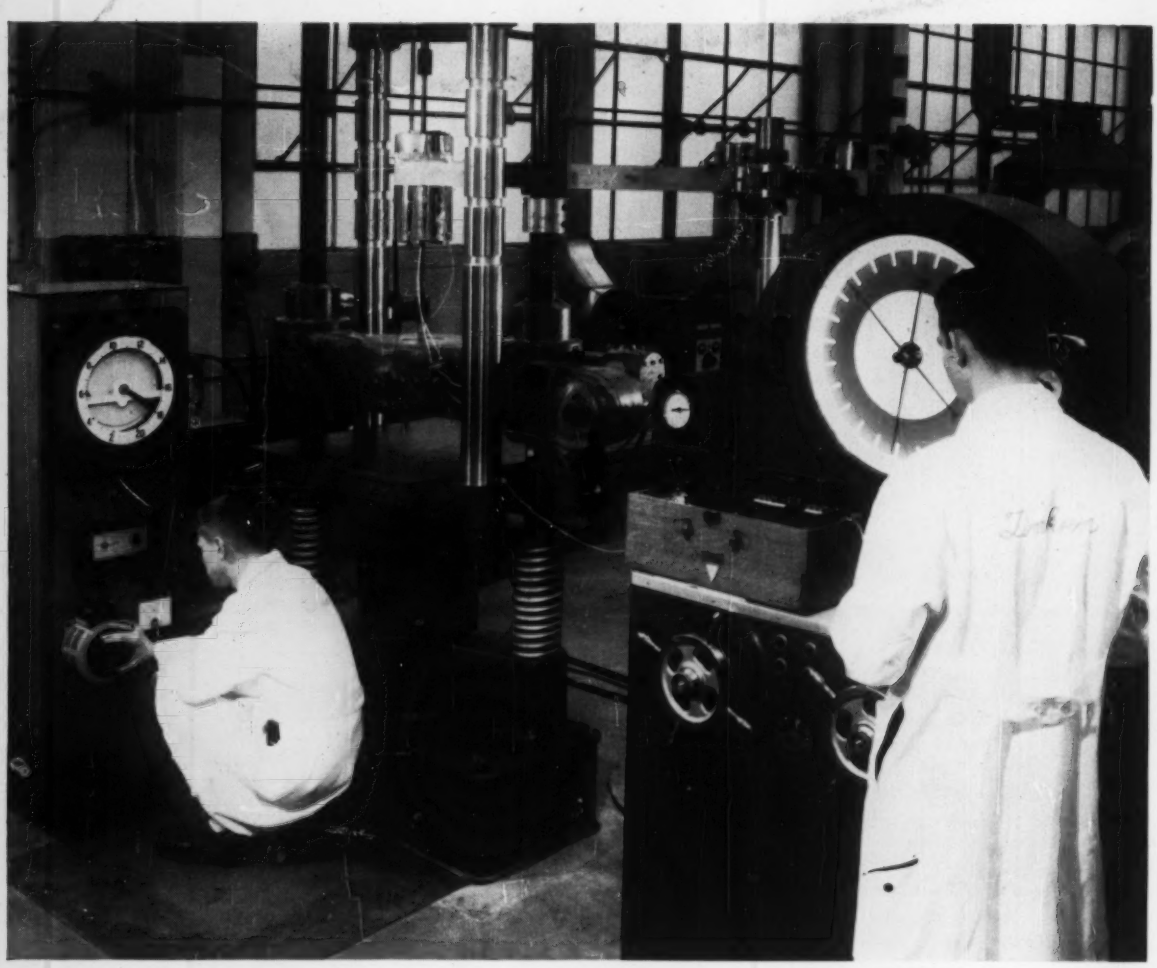

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